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(S. J. SAINT, M.Sc., PH.D., F.I.C.)

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ERRATA.

P. 20—line 3 from bottom—for "resules" read "results."

P. 57—line 19—for "compechianum" read "campechianum."

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A DISCUSSION OF THE RESULTS OF MANURIAL TRIALS CARRIED OUT ON SUGAR CANE IN BARBADOS, 1928—32.

S. J. SAINT, M.Sc., Ph.D., F.I.C.

The manurial trials, the results of which are to be discussed, were laid out in the form of randomised blocks according to the methods described by R. A. Fisher (1). The lay-out of these experiments has, in most cases, been described in previous annual reports of this Department. In this article it is proposed to discuss the effect of certain factors on the yield of sugar cane in Barbados, and, for this purpose, the figures obtained for each such factor have been drawn from various trials. The value of the difference between the mean yields of different treatments which, under the conditions of the experiment, has a 20:1 chance of being due to treatment, has been calculated and is given at the base of each table.

1. The Value of Water.

Even a casual study of conditions in Barbados is sufficient to show that the main limiting factor affecting the yield of sugar cane is water. This fact is well brought out in Table I., where the yield of sugar cane expressed in terms of sugar and the average rainfall for the growing seasons 1930—31 and 1931—32 are given.

TABLE I.

Time.	Rainfall (ins.)	Crop (tons sugar).
Dec. 1929—March 1931 ..	46.5	61,500
Dec. 1930—March 1932 ..	84.3	103,000

The mean rainfall for the growing season of the past twenty years is about 66 inches, so that the rainfall conditions for the growing seasons shown in Table I. depart considerably from the average.

A manurial trial (2) which illustrates the limiting value of water on the yield of sugar cane under Barbados conditions, may be quoted although it was designed to yield other information. This trial was planned on the lines of general estate practice with the object of determining the effects of different amounts of nitrogen, phosphate and potash and of different times of application of nitrogen on the yield of plant cane grown on land which had previously received sixteen tons of pen manure per acre. The trial was laid down at a black and a red soil centre and the rainfall may be described as approximating to the average at the red soil centre, but as very much below the average at the black soil centre. There were ten treatments which were each replicated six times, but at both cen-

tres the sixteen tons of pen manure masked the differential response of the other treatments; so that there were no significant differences between the mean yields of the different treatments. The mean yield of all plots at the red soil centre was 41.4 tons of cane per acre, whilst at the black soil centre the mean yield was 18.2 tons of cane per acre. Since the plots at both centres were treated similarly and the differences between the yields of differently treated plots at any one centre showed that the yield was not limited by lack of added fertilizer, it is evident that the difference between the yields at the red and black soil centre is due mainly, if not entirely, to rainfall differences. It should perhaps be added that given optimum rainfall conditions, little difference is seen between the yields of black and red soil estates in Barbados.

2. The Value of Mulching.

A study of the rainfall conditions in Barbados show that between January and May or June there is a well marked dry season and that most of the rainfall for the year falls between July and December. During the dry months of the year, the prevailing conditions of high winds and hot sun favour excessive evaporation of water from the soil and, where exposed, the soil dries out and, towards the end of the dry season, cracks of various sizes and depths may appear in the cane fields. If the soil is covered down with a mulch of organic matter, this loss of water is minimised as can be seen by the relative appearances of the cane and the soil. At the end of the dry season the colour, height and vigour of young cane which has been effectively mulched at the commencement of the dry season, is very marked when compared with cane which has not been mulched.

In Table II. the effect on the yield of sugar cane of mulching with trash before the dry season commences, is shown (3).

TABLE II.

Treatment.	Red Soil (1928—30). Mean Yield of 6 Plots. (tons per acre).	Black Soil (1928—30). Mean Yield of 6 Plots. (tons per acre).
Trash Mulch + Artificials ...	40.0	30.6
No Mulch + Same Artificials ..	36.0	26.9
Difference ..	4.0	3.7

Statistical Analysis. A difference between mean yields of 2.8 tons per acre has a 20:1 chance of being due to treatment.

It will be noted from these figures, which were obtained under conditions closely approximating those of an average year, that conservation of moisture by mulching at the commencement of the dry season may be expected to give an increased yield of about 4 tons cane per acre.

3. The Value of Phosphates.

In Tables III.—VII. are set out the effects of phosphate on the yield of cane grown at different red and black soil centres. It is evident from a consideration of these results that sugar cane growing on the coral limestone soils of Barbados does not respond to phosphatic manuring. These results are supported by the large number of cane juice analyses which have been carried out on cane reaped at the various variety trial stations. It has been found that the phosphoric acid content of the juice of cane grown on these soils is invariably high (7).

There appears to be a number of reasons why phosphatic manuring for sugar cane in Barbados is, at present, unnecessary. These may be enumerated as follows:—

(1) The coral limestone soils are naturally rich in phosphates.

(2) The phosphate requirement of sugar cane is small.

(3) Most of the phosphate removed by the sugar cane will find its way back to the soil, since the phosphate in the juice is precipitated in the factory and goes back to the land in the filter press cake.

(4) Pen manure has been used liberally on these soils for at least a century and much of the phosphate in the food of the animals will have gone to enrich the phosphate reserves of the soil.

TABLE III.

Red Soil Centre (4) 1928—30.

Treatment per acre.	Mean Yield of 10 plots.	Difference.
	(tons per acre).	
No P_2O_5	34.9	0
72 lb. P_2O_5 .. .. as Superphosphate.	34.9	0

TABLE IV.

Red Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots.	Difference.
	(tons per acre).	
No P_2O_5	22.1	0
60 lb. P_2O_5 .. .. as Superphosphate.	22.7	+ 0.6

Statistical Analysis. A difference between mean yields of 1.7 tons has a 20:1 chance of being due to treatment.

TABLE V.

Red Soil Centre (6) 1929—31.

Treatment per acre.	Mean Yield of 6 plots.	Difference.
	(tons per acre).	
No P_2O_5	40.9	0
40 lb. P_2O_5 .. .. as Superphosphate.	40.6	— 0.3
80 lb. P_2O_5 .. .. as Superphosphate.	41.7	+ 0.8

Statistical Analysis. A difference between mean yields of 5.2 tons has a 20:1 chance of being due to treatment.

TABLE VI.

Black Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots.	Difference.
	(tons per acre).	
No P_2O_5	35.4	0
60 lb. P_2O_5 .. .. as Superphosphate.	34.5	— 0.9

Statistical Analysis. A difference between mean yields of 2.1 tons has a 20:1 chance of being due to treatment.

TABLE VII.

Black Soil Centre (6) 1929—31.

Treatment per acre.	Mean Yield of 6 plots.	Difference.
	(tons per acre).	
No P_2O_5	19.6	0
40 lb. P_2O_5 .. .. as Superphosphate.	17.4	— 2.2
80 lb. P_2O_5 .. .. as Superphosphate.	17.8	— 1.8

Statistical Analysis. A difference between mean yields of 2.3 tons has a 20:1 chance of being due to treatment.

4. The Value of Potash.

The sugar cane, like all carbohydrate producing plants, needs adequate supplies of potash for its maximum development. Cane analyses (8) indicate that under Barbados conditions, the cane crop removes between 60—100 lb. K_2O per acre, according to the yield of cane. The potash in the juice of the sugar cane is not removed in the manufacturing process, but persists through to the final molasses much of which leaves the plantation. There is thus a

continued drain of potash from the soil and it is therefore not surprising to find that, unless added as manure, potash quickly becomes a limiting factor, as far as the yield of sugar cane is concerned, in Barbados soils.

In Tables VIII—XIII. the effects of potash on the yield of plant cane are set out and it will be noted that in the three experiments quoted on the red soils, potash has shown itself to be definitely deficient. At the black soil centres, on the other hand, the addition of potash has had little or no effect on the yield indicating that, under the other conditions prevailing, the reserves of potash in the soil were sufficient to grow the maximum crop.

The explanation of the different behaviour of the red and black soils is interesting in that it sheds some light on the customary practice of manuring cane in Barbados. Cane is rarely ratooned on the black soils, whereas, on the red soils, two, three or more crops of ratoons may be reaped. The plant cane on both black and red soils is generally manured liberally with pen manure and artificials and hence is unlikely to suffer from lack of potash. On the other hand it is a general practice to give ratoon cane an application of 1 cwt. of nitrate of potash per acre, which will supply about 45 lbs. K_2O. This is considerably less than the amount of potash removed from the soil, hence the ratoon crop must draw on the potash reserves. The question arises as to whether the drop in yield of ratooned cane in the third and fourth years is not partly due to the fact that potash has become a limiting factor. The results of the manurial trials on plant cane carried out in the ratooning areas, make this contingency extremely probable and experiments are in progress on ratooned cane to test out the effect of varying amounts of potash on the yield of cane which is ratooned over a series of years. In the meantime, planters are recommended to apply the equivalent of 100 lb. K_2O per acre in their manurial application to ratooned cane growing on the coral limestone soils. Analyses show that the Scotland soils appear to have much greater reserves of potash than the coral limestone soils and, until manurial trials are carried out on typical Scotland soils, it is not possible to apply these results with any certainty to ratoons growing on these soils.

TABLE VIII.

Red Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots.	Difference.
	(tons per acre).	
No K_2O	18.7	0
112 lbs. K_2O as Sulphate of Potash ..	26.1	+ 7.4

Statistical Analysis. A difference between mean yields of 1.7 tons has a 20:1 chance of being due to treatment.

TABLE IX.

Red Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 8 plots.	Difference.
	(tons per acre).	
No K_2O	36.3	0
100 lb. K_2O as Sulphate of Potash ..	39.9	+ 3.6

Statistical Analysis. A difference between the mean yields of 3.7 tons has a 20:1 chance of being due to treatment.

TABLE X.

Red Soil Centre (6) 1930—32.

Treatment per acre. (K_2O as Sulphate of Potash).	Mean Yield of 16 plots. (tons per acre).	Difference.
No K_2O	37.2	0
40 lb. K_2O	39.3	+ 2.1
80 lb. K_2O	41.2	+ 4.0
120 lb. K_2O	43.4	+ 6.2

Statistical Analysis. A difference between the mean yields of 2.2 tons has a 20:1 chance of being due to treatment.

TABLE XI.

Black Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots.	Difference.
	(tons per acre).	
No K_2O	35.0	0
112 lb. K_2O as Sulphate of Potash ..	35.0	0

Statistical Analysis. A difference between the mean yields of 2.1 tons has a 20:1 chance of being due to treatment.

TABLE XII.

Black Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 8 plots.	Difference.
	(tons per acre).	
No K_2O	38.9	0
100 lb. K_2O as Sulphate of Potash ..	40.7	+ 1.8

Statistical Analysis. A difference between the mean yields of 3.2 tons has a 20:1 chance of being due to treatment.

TABLE XIII.

Black Soil Centre (6) 1930—32.

Treatment per acre. (K_2O as Sulphate of Potash).	Mean Yield of 16 plots. (tons per acre).	Difference.
No K_2O	45.6	0
40 lb. K_2O	47.4	+ 1.8
80 lb. K_2O	47.0	+ 1.4
120 lb. K_2O	44.3	— 1.3

Statistical Analysis. A difference between the mean yields of 3.5 tons has a 20:1 chance of being due to treatment.

5. Sulphate Versus Muriate of Potash.

Four or five years ago, there was little or no muriate of potash used in Barbados although the substitution of muriate for sulphate or nitrate of potash would effect no inconsiderable saving in the manure bill.

An experiment was carried out to test the effects of sulphate and muriate of potash on the yield of cane and on the purity of the juice (9); it was planned on the A.B.B.A. method of Student with ten replicates of each treatment and samples of cane were taken from all plots for juice analyses.

The essential results of the experiment are set out in Table XIV., where it will be seen that there are no significant differences between the yield or the purity of the juices from the sulphate and muriate plots.

TABLE XIV.

Treatment.	Mean Yield. (Tons per acre)	Mean Sucrose in Juice.	Mean Purity of Juice.
134 lb. K_2O as Muriate ..	35.48	16.01	88.56
134 lb. K_2O as Sulphate ..	36.37	16.07	88.50

Statistical Analysis. A difference between mean yields of 2.5 tons has a 20:1 chance of being due to treatment.

From the results of this experiment there seems no reason why muriate of potash should not be used to replace sulphate of potash on the coral limestone soils of Barbados.

6. The Value of Nitrogen.

In view of the fact that an average crop of cane in Barbados removes about 45 lb. nitrogen per acre from the soil, the general estate practice, as regards nitrogenous manuring, appears to be very liberal. Most cane land receives, as a minimum, 8 tons of pen manure each growing season, which will supply about 90 lb. nitrogen per acre. In addition, it is customary to give an early cane manure, a month or two after the cane is planted, which will contain about 20 lb. of readily available nitrogen per acre; subsequently, when the rainy season commences, another application of 56—80 lb. nitrogen for plant canes and up to 112 lb. nitrogen for ratoons per acre is given in the form of sulphate of ammonia. This later application of nitrogen has a rapid effect on the cane foliage which turns from a yellowish to a dark green.

In Tables XV.—XX. the effects of additions of nitrogen, as sulphate of ammonia, on the yield of plant cane, are set out. It will be noticed that these applications of sulphate of ammonia have had very varying effects at the different centres. In some cases, there is a marked response to nitrogenous manuring whilst, in other cases, the application of sulphate of ammonia has had little or no effect on the yield. Soil analyses (10) show that the nitrogen content of most local soils fall within the limits 0.12—0.20%, although the minimum and maximum figures so far obtained are 0.078% and 0.291% respectively. It would appear then that the response of sugar cane to nitrogenous manuring will depend very largely on the general condition and previous treatment of the soil.

Further trials to test out the general estate practice of nitrogenous manuring of plant cane and ratoons are to be carried out. But, for the present, it can be said that there is no evidence to show that more than 60—80 lb. nitrogen per acre as sulphate of ammonia is necessary.

TABLE XV.

Red Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots. (Tons per acre).	Difference.
No Nitrogen	21.8	0
67 lb. Nitrogen as Sulphate of Ammonia ..	23.0	+ 1.2

Statistical Analysis. A difference between mean yields of 1.7 tons per acre has a 20:1 chance of being due to treatment.

TABLE XVI.

Red Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 8 plots. (Tons per acre).	Difference.
No Nitrogen	34.5	0
60 lb. Nitrogen as Sulphate of Ammonia ..	41.7	+ 7.2

Statistical Analysis. A difference between mean yields of 3.7 tons per acre has a 20:1 chance of being due to treatment.

TABLE XVII.

Red Soil Centre (6) 1930—32.

Treatment per acre. (Nitrogen as Sulphate of Ammonia).	Mean Yield of 16 plots. (Tons per acre).	Difference.
No Nitrogen	39.5	0
40 lb Nitrogen ..	40.7	+ 1.2
80 lb. Nitrogen ..	40.9	+ 1.4
120 lb. Nitrogen ..	40.1	+ 0.6

Statistical Analysis. A difference between mean yields of 2.2 tons per acre has a 20:1 chance of being due to treatment.

TABLE XVIII.

Black Soil Centre (5) 1928—30.

Treatment per acre.	Mean Yield of 24 plots. (Tons per acre).	Difference.
No Nitrogen	33.7	0
67 lb. Nitrogen as Sulphate of Ammonia ..	36.2	+ 2.5

Statistical Analysis. A difference between mean yields of 2.1 tons per acre has a 20:1 chance of being due to treatment.

TABLE XIX.

Black Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 8 plots. (Tons per acre).	Difference.
No Nitrogen	37.8	0
60 lb. Nitrogen as Sulphate of Ammonia ..	41.8	+ 4.0

Statistical Analysis. A difference between mean yields of 3.2 tons per acre has a 20:1 chance of being due to treatment.

TABLE XX.

Black Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 16 plots. (Tons per acre).	Difference.
(Nitrogen as Sulphate of Ammonia).		
No Nitrogen	46.7	0
40 lb Nitrogen ..	45.0	— 1.7
80 lb. Nitrogen ..	46.0	— 0.7
120 lb. Nitrogen ..	46.6	— 0.1

Statistical Analysis. A difference between mean yields of 3.5 tons per acre has a 20:1 chance of being due to treatment.

7. The Value of Pen Manure.

The application of pen manure to sugar cane is a general practice in Barbados and has been for very many years. The value of pen manure is well known and the results on the yield of plant cane of varying applications are set out in Tables XXI.—XXIV.

It would appear from these results that any pen manure supplied in addition to an application of ten tons per acre, has had no effect on the yield of cane.

If of general application, this is an important conclusion since it is a common practice in Barbados to give dressings of from 30 to 60 tons of pen manure per acre.

TABLE XXI.

Red Soil Centre (3) 1928—30.

Treatment per acre.	Mean Yield of 6 plots (Tons per acre).	Difference.
No Manure	26.7	0
15 tons Pen Manure + Artificials ..	39.1	+ 12.4
30 tons Pen Manure ..	38.5	+ 11.8

Statistical Analysis. A difference between mean yields of 3.1 tons per acre has a 20:1 chance of being due to treatment.

TABLE XXII.

Red Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 4 plots. (Tons per acre).	Difference.
No Manure	32.5	0
10 tons Pen Manure ..	40.6	+ 8.1
20 tons Pen Manure ..	40.6	+ 8.1
30 tons Pen Manure ..	40.2	+ 7.7

Statistical Analysis. A difference between mean yields of 5.2 tons per acre has a 20:1 chance of being due to treatment.

TABLE XXIII.

Black Soil Centre (3) 1928—30.

Treatment per acre.	Mean Yield of 6 plots. (Tons per acre).	Difference.
No Manure	22.4	0
15 tons Pen Manure + Artificials	29.7	+ 7.3
30 tons Pen Manure ..	27.1	+ 4.7

Statistical Analysis. A difference between mean yields of 4.7 tons per acre has a 20:1 chance of being due to treatment.

TABLE XXIV.

Black Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 4 plots. (Tons per acre).	Difference.
No Manure	37.3	0
10 Tons Pen Manure ..	35.8	— 1.5
20 Tons Pen Manure ..	38.4	+ 1.1
30 Tons Pen Manure ..	38.0	+ 0.7

Statistical Analysis. A difference between mean yields of 4.5 tons per acre has a 20:1 chance of being due to treatment.

8. The Value of Pen Manure Plus Artificial Manures.

As mentioned in paragraph 6, it is a general custom in Barbados to give an early cane manure supplying nitrogen, potash and sometimes phosphates and, later, a further dressing of quickly available nitrogen to cane which is grown on land previously dressed with pen manure.

In Tables XXV. and XXVI are given the results of field trials in which the effects of 100 lb. of potash as sulphate of potash and 60 lb. nitrogen as sulphate of ammonia per acre, were investigated on the yield of cane which had received varying dressings of pen manure.

TABLE XXV.

Red Soil Centre (6) 1930—1932.

Treatment per acre.	Mean Yield of 4 plots (Tons per acre).	Difference.
10 Tons Pen Manure	40.6	— 0.1
10 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	40.5	
20 Tons Pen Manure	40.6	+ 6.4
20 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	47.0	
30 Tons Pen Manure	40.2	+ 6.7
30 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	46.9	
Difference between mean yields of 12 plots		+ 4.3

Statistical Analysis. A difference between mean yields of 4 plots of 5.2 tons has a 20:1 chance of being due to treatment.

A difference between the mean yields of 12 plots of 3.0 tons has a 20:1 chance of being due to treatment.

TABLE XXVI.

BLACK SOIL CENTRE (6) 1930—1932.

Treatment per acre.	Mean Yield of 4 plots (Tons per acre).	Difference.
10 Tons Pen Manure	35.8	+ 3.8
10 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	39.6	
20 Tons Pen Manure	38.4	+ 2.0
20 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	40.4	
30 Tons Pen Manure	38.0	+ 3.7
30 Tons Pen Manure + 100 lb. K_2O + 60 lb. N.	41.7	
Difference between mean yields of 12 plots		+ 3.2

Statistical Analysis. A difference between mean yields of 4 plots of 4.5 tons has a 20:1 chance of being due to treatment.

A difference between mean yields of 12 plots of 2.6 tons has a 20:1 chance of being due to treatment.

The results of these experiments indicate that the addition of sulphate of potash and sulphate of ammonia to applications of pen manure, will give an increased yield of the treated cane. This increased yield is independent of whether a dressing of 10, 20, or 30 tons of pen manure is applied.

In these same trials, the effects of either 60 lb. nitrogen as sulphate of ammonia per acre, or 100 lb. potash as sulphate of potash per acre, were also investigated on the yield of cane which had received varying dressings of pen manure. The results of these experiments are set out in Tables XXVII. and XXVIII.

TABLE XXVII.

Treatment per acre.	Mean Yield of 4 plots (Tons per acre.)		Difference.	
	Red Soil Centre	Black Soil Centre.	Red Soil Centre	Black Soil Centre
10 Tons Pen Manure	40.6	35.8		
10 Tons Pen Manure + 60 lbs. N. ..	38.5	38.0	— 2.1	+ 2.2
20 Tons Pen Manure	40.6	38.4		
20 Tons Pen Manure + 60 lbs. N. ..	40.6	40.4	0	+ 2.0
30 Tons Pen Manure	40.2	38.0		
30 Tons Pen Manure + 60 lbs. N. ..	41.9	41.5	+ 1.7	+ 3.5
Difference between means of 12 plots			— 0.1	+ 2.6

Statistical Analysis. A difference between the mean yields of 4 plots of 5.2 tons for Red Soil Centre and 4.5 tons for Black Soil Centre has a 20:1 chance of being due to treatment.

A difference between the mean yields of 12 plots of 3.0 tons for Red Soil Centre and 2.6 tons for Black Soil Centre has a 20.1 chance of being due to treatment.

TABLE XXVIII.

Treatment per acre.	Mean Yield of 4 plots. (Tons per acre).		Difference.	
	Red Soil Centre.	Black Soil Centre.	Red Soil Centre.	Black Soil Centre.
10 Tons Pen Manure ..	40.6	35.8		
10 Tons Pen Manure + 100 lb. K_2O ...	44.8	37.2	+ 4.2	+ 1.4
20 Tons Pen Manure ..	40.6	38.4		
20 Tons Pen Manure + 100 lb. K_2O	41.5	36.9	+ 0.9	— 1.5
30 Tons Pen Manure ..	40.2	38.0		
30 Tons Pen Manure + 100 lb. K_2O	44.5	39.8	+ 4.3	+ 1.8
Difference between means of 12 plots ..			+ 3.1	+ 0.6

Statistical Analysis. A difference between means yields of 4 plots of 5.2 tons for Red Soil Centre and 4.5 tons for Black Soil Centre has a 20:1 chance of being due to treatment.

A difference between yields of 12 plots of 3.0 tons for Red Soil Centre and 2.6 tons for Black Soil Centre has a 20:1 chance of being due to treatment.

These results are interesting in that they show that, at the red soil centre, the addition of potash to pen manure has increased the yield of cane, whilst the addition of nitrogen has had no effect; at the black soil centre, on the other hand, the reverse has been the case. It is evident from these experiments that if cane is grown on land deficient in potash or nitrogen, the maximum yield of cane cannot be obtained with pen manure alone, but available potash and/or nitrogen must be supplied in the form of artificial manures. The plantation practice of applying artificial manures in conjunction with pen manure is therefore supported by the results of these trials.

9. Pen Manure Versus Trash plus Artificial Manures.

The cost of making and applying pen manure and of the upkeep of stock are large items in the cost accounts of average Barbadian plantations. Savings could be effected on both these items by the substitution of other and cheaper manures for pen manure so long as the fertility of the soil and yield of cane were maintained. In Tables XXIX.—XXXII. the effect of pen manure on the yield is compared with the method of mulching and manuring with artificials. It will be seen that equally good returns of cane are obtained by both methods and, undoubtedly, the pen manure system is more expensive.

Pen manure has been the stable manure in Barbados for so many years that it has come to be regarded by some planters as indispensible. In fact, on some plantations, part of the stock are kept for the sole purpose of making manure. A recognition of the fact that pen manure can be replaced by other manures, would lead to a more general adoption of mechanical transport which is recognised to be more economical than transport by stock.

TABLE XXIX.

Red Soil Centre (3) 1928—30.

Treatment per acre.	Mean Yield of 6 Plots. (Tons per acre).	Difference.	Cost of Manures per acre.
Trash Mulch + Artificials ..	40.0	0	28.0
15 Tons Pen Manure + Artificials ..	39.0	— 1.0	45.0
30 Tons Pen Manure	38.5	— 1.5	44.8

Statistical Analysis. A difference between mean yields of 3.1 tons per acre has a 20:1 chance of being due to treatment.

TABLE XXX.

Red Soil Centre (6) 1930—32.

Treatment per acre.	Mean Yield of 4 plots (Tons per acre).	Difference.
Trash Mulch + K1 N1	43.3	0
10 Tons Pen Manure + K1 N1 ..	40.5	— 2.8
20 Tons Pen Manure + K1 N1 ..	47.0	+ 3.7
30 Tons Pen Manure + K1 N1 ..	46.9	+ 3.6

Statistical Analysis. A difference between mean yields of 5.2 tons per acre has a 20:1 chance of being due to treatment.

Notes. K1 = 100 lb. potash as Sulphate of potash.
N1 = 60 lb. nitrogen as Sulphate of ammonia.

TABLE XXXI.

Black Soil Centre (3) 1928—30.

Treatment per acre.	Mean yield of 6 plots (Tons per acre).	Difference.	Cost of Manures per acre. $
Trash Mulch + Artificials ..	30.6	0	28.0
15 Tons Pen Manure + Artificials ..	29.6	— 1.0	45.0
30 Tons Pen Manure	27.1	— 3.5	44.8

Statistical Analysis. A difference between mean yields of 4.7 tons per acre has a 20:1 chance of being due to treatment.

TABLE XXXII.

BLACK SOIL CENTRE (6) 1930—32.

Treatment per acre.	Mean Yield of 4 plots (Tons per acre).	Difference.
Trash Mulch + K1 N1	43.1	0
10 Tons Pen Manure + K1 N1 ..	39.6	— 3.5
20 Tons Pen Manure + K1 N1 ..	40.4	— 2.7
30 Tons Pen Manure + K1 N1 ..	41.7	— 1.4

Statistical Analysis. A difference between mean yields of 4.5 tons per acre has a 20:1 chance of being due to treatment.

Notes. K1 = 100 lb. potash as Sulphate of potash.
N1 = 60 lb. nitrogen as Sulphate of ammonia.

10. THE RESIDUAL VALUE OF PEN MANURE.

It might be argued that one of the chief attributes of pen manure is in its residual value which will serve to benefit succeeding crops. This matter has been investigated by reaping further crops from the experimental plots either in the form of ratooned cane or as maize. Inasmuch as it is a general plantation practice to manure ratoons irrespective of the amount of pen manure which they received as plant canes, the ratoons in these experiments were also manured. The crop of maize was grown without manure. The yield results are set out in Tables XXXIII. and XXXIV.

It will be seen that the residual value of pen manure, if any, has been masked by the application of the artificial manures to the ratoons. It can therefore be concluded that, in general estate practice, the pen manure applied to plant cane will have little, if any, effect on the yield of the ratoon cane.

TABLE XXXIII.

RED SOIL CENTRE (3) 1928—30; 1931; 1932.

Treatment per acre.		Mean Yields of 6 plots (Tons per acre).		
Plant Cane.	First and Second Ratoons.	Plant Cane.	1st Ratoons.	2nd Ratoons.
Trash Mulch + Artificials	K + N. .	40.0	30.2	30.3
15 Tons Pen Manure + Artificials	K + N.	39.1	31.8	31.8
30 Tons Pen Manure ..	K + N.	38.5	32.9	31.3

Statistical Analysis. A difference between mean yields of 3.1 for plant canes; 3.2 tons for 1st Ratoons and 2.7 tons for 2nd Ratoons has a 20:1 chance of being due to treatment.

Notes. K = 100 lb. potash as sulphate of potash.
N = 67 lb. nitrogen as sulphate of ammonia.

TABLE XXXIV.

BLACK SOIL CENTRE (3) 1928—30; 1931.

Treatments per acre.			Mean Yield of 6 plots (Tons per acre).		
Plant Canes.	Ratoons.	Maize.	Plant Canes.	1st Ratoons.	Maize.
Trash Mulch + Artificials ..	K + N	0	30.6	16.2	1.432
15 Tons Pen Manure + Artificials ..	K + N	0	29.7	16.9	1.478
30 Tons Pen Manure	K + N	0	27.1	16.1	1.556

Statistical Analysis. A difference between mean yields of 4.7 tons for plant canes; 2.5 tons for 1st ratoons and 0.202 tons for maize has a 20:1 chance of being due to treatment.

Notes. K = 100 lb. potash as sulphate of potash.
N = 67 lb. nitrogen as sulphate of ammonia.

11. The Value of other "Organic" Manures.

It is a general opinion in Barbados that if pen manure cannot be applied to sugar cane in any year, then some kind of manure supplying organic nitrogen must be supplied. Fish Manure, Sheep Manure and Mixed Manures containing Cotton Seed Meal are extensivly used although these manures are expensive when valued on their contents of nitrogen and potash.

Experiments were carried out to compare the effect of these manures with a mixture of sulphate of ammonia, superphosphate and sulphate of potash, on the yield of cane. The results of these experiments which are set out in Tables XXXV—XXXVI show that a simple mixture of artificials supplying the same nutrients, gives as good returns as these "organic manures" and at a much less cost.

TABLE XXXV.

Red Soil Centre (3) 1928—30.

Treatment per acre.	Nutrients lb.			Mean Yield of 6 plots.	Difference.	Cost of Manuring per acre.
	N.	P_2O_5	K_2O	(Tons per acre.)		$
3½ cwt. Sulphate of Ammonia ... + 3 cwt. Superphosphate ... .. + 3 cwt. Sulphate of Potash	78	67	168	36·1	0	24·0
15 cwt. Fish Manure	69	78	168	35·8	– 0·3	45·0
3½ Tons Sheep „	106	67	138	33·4	– 2·7	45·5
1½ Ton Cotton Seed Manure ... .. + 1 cwt. Sulphate of Potash	141	134	110	35·4	– 0·7	45·3

Statistical Analysis. A difference between mean yields of 3.1 tons per acre has a 20.1 chance of being due to treatment.

TABLE XXXVI.

BLACK SOIL CENTRE (3) 1928—30.

Treatment per acre.	Nutrients lb.			Mean Yield of 6 plots.	Difference.	Cost of Manuring per acre.
	N.	P_2O_5	K_2O	(Tons per acre.)		$
3½ cwt. Sulphate of Ammonia .. + 3 cwt. Superphosphate ... ... + 3 cwt. Sulphate of Potash	78	67	168	27·1	0	24·0
15 cwt Fish Manure	69	78	168	25·8	−1·3	45·5
3½ Tons Sheep ,,	106	67	138	26·0	−1·1	45·5
1½ Tons Cotton Seed Manure ... ... + 1 cwt. Sulphate of Potash...	141	134	110	29.3	2·2	45.3

Statistical Analysis. A difference between mean yields of 4.7 tons per acre has a 20:1 chance of being due to treatment.

12. THE RESIDUAL VALUE OF "ORGANIC" MANURES.

The residual values of the organic manures mentioned in the preceding section were determined by continuing to crop the plots. The customary estate practice of manuring ratoons and not the maize crop, was followed. The yield resules are set out in Tables XXXVII and XXXVIII., from which it can be concluded that, under estate practice, the application of these manures to plant cane will have little, if any, effect on the succeeding crops.

TABLE XXXVII.

RED SOIL CENTRE (3) 1928—30; 1931; 1932.

Treatment per acre.		Mean Yield of 6 plots (Tons per acre).		
Plant Canes.	1st & 2nd Ratoons.	Plant Canes.	1st Ratoons.	2nd Ratoons.
Mixture of Artificials ..	N + K	36.1	32.2	29.5
15 cwts. Fish Manure ..	N + K	35.8	31.9	30.5
3½ Tons Sheep Manure ..	N + K	33.4	32.4	30.4
1½ Tons Cotton Seed Manure + 1 cwt. Sulphate of Potash	N + K	35.4	33.3	30.2

Statistical Analysis. A difference between mean yields of 3.1 tons for plant canes; 3.2 tons for 1st ratoons and 2.7 tons for 2nd ratoons has a 20:1 chance of being due to treatment.

TABLE XXXVIII.

BLACK SOIL CENTRE (3) 1928—30; 1931.

Treatment per Acre.			Mean yield of 6 plots. (Tons per acre).		
Plant Canes.	Ratoons.	Maize.	Plant Canes.	Ratoons.	Maize.
Mixture of Artificials	N + K	0	27.1	14.7	1.448
15 cwts. Fish Manure	N + K	0	25.8	16.9	1.335
3½ tons Sheep Manure	N + K	0	26.0	16.8	1.485
1½ Tons Cotton Seed Manure + 1 cwt. Sulphate of Potash	N + K	0	29.3	14.2	1.541

Statistical Analysis. A difference between mean yields of 4.7 tons for plant canes; 2.5 tons for 1st ratoons and 0.202 tons for maize has a 20:1 chance of being due to treatment.

Notes to Tables XXXVII and XXXVIII.

N = 67 lb. nitrogen as sulphate of ammonia.
K = 100 lb. potash as sulphate of potash.

FINAL CONCLUSIONS AND PRACTICAL RECOMMENDATIONS.

The results of the manurial trials carried out to date, enable a number of recommendations to be made which, if adopted, should help to reduce the costs of producing sugar cane in Barbados. These recommendations are based mainly on the fact that the supply of water, potash and nitrogen are the principal factors affecting the yield of sugar cane in Barbados.

1. Water.

As far as water is concerned, the main practical consideration to aim at is the conservation of soil moisture so as to enable the cane plant to utilise the greatest possible percentage of the total rainfall. To achieve this end two recommendations are put forward:

(a) Losses of water from the soil should be minimised during the dry season by mulching the cane with trash, sour grass or other organic matter, or by maintaining a loose covering of surface soil with the aid of harrows. Experiment shows that, in a normal year, mulching will result in an increased yield of about 4 tons of cane per acre.

(b) The humus reserves of the soil should be maintained and increased in order to raise the drought resisting properties of the soil. The amount of organic matter now available on the plantation is derived mainly from the trash of the sugar cane and from the sour grass pastures. The total organic matter on the plantation may be increased by the manuring of the sour grass pastures and by green manuring. Manurial trails carried out on typical sour grass pastures (11) show that the yield of grass may be increased by 200—300% by manuring.

2. Nitrogen and Potash.

Manurial trials show that, under the normal rainfall conditions, an application of 60—80 lbs. of available nitrogen and 80—100 lbs. of available potash are sufficient nutrients per acre to grow the maximum crop.

The evidence which has been obtained indicates that there is no advantage to be gained by applying these nutrients in any particular form. The method which is at present the cheapest, viz., to supply the nitrogen as sulphate of ammonia and the potash as muriate of potash, gives as good returns as any other.

The manuring recommended for the planter for both plant cane and ratoons would therefore be as follows:—

In January— 2—2½ cwts. per acre of a mixture of three parts sulphate of ammonia and five parts muriate of potash (60% K_2O)

In July — (when the rains commence). 2—2½ cwts. of sulphate of ammonia per acre.

3. Pen Manure.

There is no evidence to show that pen manure is necessary and essential on Barbados soils. Sugar cane treated as outlined in paragraphs 1 and 2 above, will give as good returns as if manured with pen manure, and at a much less cost. The results of the field trials also indicate that pen manure applied in excess of 10—15 tons per acre will have little, if any, influence on the yield of cane. Further, if the land is deficient in potash and/or nitrogen, the maximum yield of cane cannot be obtained with pen manure alone, but available potash and/or nitrogen must be supplied, in addition to the pen manure, in the form of artificial manures.

A reduction in the amount of pen manure made on the plantations, could be followed by a reduction in the number of stock kept and a saving in the stock feed bill. More trash and other organic matter would also be available for the purposes of mulching and subsequent incorporation with the soil. It is therefore recommended that the number of stock on the plantation should be reduced to the minimum compatible with the efficient operation of the plantation and where necessary, tractors or some other type of mechanical power should be utilised to take the place of the stock displaced.

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Some Aspects of the Flora of Barbados.

BY

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(*Continued from last issue*).

4TH INSTALMENT.

DIVISION A.—*Continued.* NATURAL PLANT COMMUNITIES

SECTION II. THE MIXED PLANT COMMUNITIES OF BARBADOS.

We now come to a consideration of the plant population of districts which offer at one and the same time two or more different sets of conditions for the growth of plants. This results in a mixture of plant types, which on investigation and analysis, proves to be made up of two or more pure associations.

It would be best to arrange the mixed plant communities of Barbados according to the general nature of the habitat. In this way we recognise the plant communities of the following regions.

(A) *Certain waste places.*
(B) *Undercliff regions of the inland terraces.*

CHAPTER XII.

(A) MIXED PLANT COMMUNITIES OF WASTE PLACES.

The waste places included under this heading are districts in which the substratum consists of bare rock with patches of soil or of sand of varying extent interspersed between the exposed rock surfaces. They gradate on the one hand into the habitat of the pure association of "plants of rock-land," and on the other hand, into "dry pasture" or "sandy beach," such as have been described in previous chapters. They may be roughly classified according to the types of vegetation that are represented in their plant population.

(1) WASTE PLACES, THE VEGETATION OF WHICH CONSISTS CHIEFLY OF A MIXTURE OF "SEA BEACH" PLANTS AND "ROCKY LAND" PLANTS.

These regions occur near the sea coast in a few localities of Barbados. The best example occurs along the top of the sea-cliff which borders the southern coast line of the Island in the neighbourhood of Spencers and Seawell estates. The land in this district is quite unfit for cultivation. Rocks jut out all over its surface. Between the rocks, pockets of sandy soil occur. The land continuously receives salt spray from the sea, since the wind blows over it almost incessantly either from the northeast or from intermediate points veering round to the south—according to the season of the year. Thus, the substratum is of such a nature that it favours the growth both of certain rock plants and of plants that can live successfully even in sandy soil containing saline moisture.

The commonest of the typical sea-beach plants occurring on the rocky land are:—

Paspalum distichum (Binding Grass); *Lippia reptans; Pectis humifusa* (Duckweed); *Hippomane mancinella* (Manchineel); *Fecoma leucoxylon* (White Wood) and the succulent halophytes, *Sesuvium portulacastrum* (Seaside samphire) and *Portulaca oleracea* (Purslane).

Of the rock plant type, the commonest plants in this district are:—

Lantana involucrata (White Sage); *Croton flavens* (Seaside Sage); *Cordia cylindristachya* (Black Sage); *Phyllanthus epiphyllanthus* (Sickle-leaved Spurge); *Jatropha gossypifolia* (Belly-ache Bush); and *Opuntia tuna* (Prickly Pear).

It is worthy of mention that in certain of the larger pockets of soil (especially those situated some distance away from the sea) in this strip of rocky land, a few plants, typically belonging to the dry pasture association, occur. The chief of them are:—

Desmodium spp.; Teramnus uncinatus; Rhynchosia minima; along with certain prostrate grasses. These together form a carpet, from which grow a few erect plants such as *Ruellia tuberosa* (Minnie Root); *Sida* spp., &c.

There is another region in Barbados where the vegetation consists essentially of a mixture of certain sandy soil forms and rocky land forms, but which exhibits several special features which make it worthy of mention. The region referred to is the rocky land in the neighbourhood of Chalky Mount in the Scotland District. Chalky Mount is a rugged spur of gritty sandstone, of height above sea-level about 550 feet, which terminates a radial ridge of high land. The Chalky Mount spur runs almost to the sea border, falling rapidly at an angle of about 60 degrees to the shore at a point just over half a mile to the south of Long Pond. The sea-ward parts of Chalky Mount for some distance inland are exposed therefore to the direct blast of the Trade Wind. The wind carries with it saline matter, which may be deposited on such plants as grow on the spur, or on the soil which occurs in pockets on its surface.

The higher regions of Chalky Mount for the most part, are bare and exposed. The gritty rock has been weathered into pinnacles, ledges, hollows and cracks. Here and there, pockets of soil of all sizes and depths occur, and occasionally on the ledges a scanty turf exists on which several grassy and prostrate plants grow successfully. The lower slopes of the Chalky Mount spur are steep and consist chiefly of debris brought down from the higher regions. In certain parts, the talus is in frequent motion, so that few plants can exist on it. In others, however, a firm turf exists which forms rough pasture land for the grazing of sheep and goats. Trees are almost entirely absent.

It is in the pockets and on the ledges of the higher windward parts of Chalky Mount and of the neighbouring elevated land that the vegetation now to be described occurs. This vegetation is on the whole xerophytic. Many shrubby plants already described as characterising certain inland rocky districts of Barbados flourish on Chalky Mount. The commonest of them are:—

Lantana involucrata and *camara; Cordia cylindristachya; Croton flavens* (Sages); *Psidium guajava* (Guava); *Phyllanthus epiphyllanthus* (Sickle-leaved Spurge); *Jatropha gossypifolia* (Belly-ache Bush); and *Opuntia tuna* (Prickly Pear). Besides these, other typical xerophytes (such as the large rare Cactus (*Cephalocerus* sp. nov:) with its thick, erect, spiny and occasionally-branched green stems; and the tall massive leaved *Agave americana* (Century plant or Maypole Bush) occur.

Along with these rocky-cliff plants, several other shrubby xerophytes abound. Of them, the following have already been described or mentioned amongst the plants of sandy tracts near the sea shore. *Coccoloba uvifera* (Seaside Grape); *Tecoma leucoxylon* (White Wood), *Clerodendron aculeatum* (Wild Coffee) and *Stachytarpheta indica* (Vervain). In the shallower pockets of sandy soil, and forming scanty turf here and there on the rocky ledges, are certain grasses, such as *Paspalum distichum* (Binding Grass); *Cenchrus echinatus* (Burr Grass); *Cynodon dactylon* (Devil's Grass); *Sporobolus indicus* (Wire Grass); and the prostrate plants *Ipomaea biloba* (Goat's-foot); *Lippia reptans* and *Pectis humifusa*. In the more sheltered places, the succulent plants *Heliotropium curassavicum* (Wild Lavender); *Sesuvium portulacastrum* (Samphire); *Portulaca oleracea* (Purslane); and *Iresine* (=*Philoxerus*) *portulacoides* also occur. Finally, two shrubby xerophytes, especially characteristic of this region, deserve mention. They are *Chrysobalanus icaco* (Fat Pork) and *Ecastaphyllum brownei* (a leguminous plant).

The conspicuous presence on Chalky Mount of the second series of halophytic plants named above, occurring as they do along with rocky-land plants, and their absence on the hill ranges further inland, points to the conclusion that they inhabit this region because of the peculiar conditions which prevail there. The peculiarity implied may be the salinity of the soil and air of the windward parts of Chalky Mount,—a conclusion favoured by the fact that many of these plants occur on or near the sea shore, or on moist rocks bordering the sea in other parts of Barbados. Their presence in the vegetation of the high waste land is the striking feature of the plant-community of Chalky Mount.

(2) WASTE PLACES, THE VEGETATION OF WHICH CONSISTS CHIEFLY OF A MIXTURE OF "ROCKY-LAND" PLANTS AND "DRY-PASTURE" PLANTS.

These regions are far more common than the last. They constitute the bulk of the uncultivated land of the inland coralline regions of Barbados. They are well represented in the south and south-east of the Island along the summit of the line of inland cliffs that runs parallel to the coast at a distance varying between half and one mile from the sea border. The height of these cliffs varies from 50 to 150 feet. Waste places of this description also occur on sugar estates in the middle of the Island, especially near the rocky edges of terraces. They embrace, according to the definition, any waste land which is too irregular and rocky to deserve the title of "dry pasture." Their vegetation includes most of the rock-plants already mentioned, and almost all these plants that characterise dry pastures, especially those that form carpets, such as certain grasses, leguminous prostrate plants, and prostrate plants of other families. The carpets occur in hollows or pockets between the bare rocks, and the groups of plants represented in each may vary somewhat from place to place.

It is not unusual to find considerable areas of land in these rocky places covered with fairly luxuriant Sour Grass, the uniformity of which, however, is broken by clumps of rock plants growing near those places where the bare rock is exposed. More commonly, the grassy herbage includes several genera, such as *Cynodon; Sporobolus; Panicum; Paspalum; Chloris*, &c., the development of which is typically prostrate and stunted.

CHAPTER XIII.

(B) THE MIXED PLANT COMMUNITY OF UNDERCLIFF REGIONS.

The inland cliffs which form a characteristic feature of the coralline region of Barbados have already been mentioned in connection with the topography of the Island. The faces of many of these cliffs are more or less hidden by vegetation consisting chiefly of small trees and shrubs, sufficiently distinctive to deserve special mention; it may be regarded as a plant community of fairly definite composition. An analysis of this vegetation reveals the presence of many plants characteristic of rocky land, mixed with certain plants more fitted for life under moister conditions. Hence the plant community of the undercliff regions may be considered as a mixed vegetation of rocky land plants and plants of an almost mesophytic type.

The district where the undercliff plants are best developed is perhaps the southern part of Barbados, especially beneath the first terrace which runs more or less parallel to the coast of the parish of Christ Church and of the adjoining part of Saint Philip.

The reasons why the vegetation is so characteristic in undercliff regions are two in number. First of all, it has been left undisturbed by man, and therefore stands out clearly from the vegetation of the cultivated land around. Secondly,

the substratum in which the more mesophytic plants are rooted is fairly deep (consisting of soil collected in pockets between the bare rock masses, or situated on talus slopes at the cliff-bases), and is provided with an almost regular supply of moisture, because of the proximity of the lime-stone cliff which provides seepage water.

The plants of the undercliff vegetation of the first inland escarpment as represented in the southern coastal region of Barbados at the cliffs below Seawell and Spencers Estates (Christ Church), include the following common forms:—

(1) **ROCKY LAND PLANTS** (growing where the sub-stratum is rocky, and where true soil is scarce).

All the plants mentioned and described under the heading "Rocky land plants" (which constitutes a xerophytic, pure plant association) are to be found in abundance in this locality.

(2) **MESOPHYTIC PLANTS** (growing in the pockets of soil between the rock masses, and on the talus slopes at the bases of the cliffs).

These are chiefly shrubs which occur occasionally in certain pure plant associations already described, but which more commonly are found growing in undercliff regions. The chief of them are the shrubby trees or shrubs, White Wood (*Tecoma leucoxylon*); Bread and Cheese (*Pithecolobium unguis-cati*); Fustic; Manchineel; Seaside Grape; Wild Coffee; Bearded Fig (*Ficus laurifolia*), (whose occurrence here is of special interest); Trigonette (*Ixora parviflora*); Pica Bush (botanical name not known); and the liane Soldier Bush (*Tournefortia volubilis*). A few creeping or trailing plants grow over the rock surface or over the stems and branches of the bushy plants. The commonest of them are—the Poison Withe (or Scratch Withe) (*Vitis sicyoides*); and the blue-flowered Convolvulus (*Jacquemontia pentantha*). Occasionally, certain more rare creepers are found. One is a slender, wiry plant which possesses small, opposite leaves, occurring in pairs at regular intervals along the stem, and which gives a milky juice on being bruised. It is a species of *Metastelma* (Asclepiadaceae). Another, is a slender woody scrambler, which produces winged fruits, each consisting of two easily separated parts. The fruits remind one of the Keys of the Maple or the Ash of temperate countries. The name of this mesophytic creeper is *Securidaca volubilis* (Polygalaceae).

DIVISION B—PLANTS OF BARBADOS WHOSE DISTRIBUTION IS LARGELY INFLUENCED BY MAN.

SECTION I.—ARTIFICIAL PLANT ASSOCIATIONS.

In this section it is intended to consider plants which are associated together in habitats whose growth conditions are being constantly influenced or have in the past been influenced, consciously or unconsciously, by human agency. The plant associations belonging to this category, in a sense, are therefore "artificial". It must be clearly understood, however, that it is by purely natural means that the plants constituting the associations gain access to the habitats which they occupy, and that the reason why certain plants only come thus to be associated together, is entirely owing to the fact that these plants happen to be suited to the prevailing conditions of growth, whereas other plants are not so suited.

The artificial plant associations of Barbados occur in the following regions:—

(1) *Cane-fields,*

(2) *Permanent "pastures" (meadows) of Sour Grass, &c.,*

(3) *Certain waste places,*

(4) *Certain waysides.*

Each region will be considered in turn, and it will be indicated in each subsection how far man has influenced the vegetation of the several habitats.

(1) PLANTS OF CANE-FIELDS: (CANE-FIELD WEEDS.)

CHAPTER XIV.

When the soil of Barbados was first prepared for the growth of crops, the early planters had to remove and destroy the native plants. The freshly-made soil thus laid bare has since been much altered by ploughing, draining and manuring, but all the time its surface has been exposed to invasion by native plants which escaped destruction. These plants have spread from gullies, roadsides, waste places, &c., their seeds being transported to the new habitat by various agents of dispersal, the chief of which is wind. Unless great care is taken to eradicate them, the invaders will occupy the soil intended for the crops, and, being sturdier and stronger, will soon gain mastery. From the planter's point of view, they are plants in the wrong place, and he calls them "weeds". It is only by the constant effort of gangs of labourers (or farmers), sent out almost every day into the cane-fields (so long as the size of the canes will allow of free working) that the weeds are kept in check.

A botanical investigation of cane-field weeds considered in relation to the peculiar conditions that prevail on cultivated soil in Barbados enables one to understand why certain kinds of plants persistently make their appearance, whereas others are never found on cane-lands. At the outset, the method of cultivation of the sugar-cane must be stated, as this is one of the most important factors. In Barbados, plant canes are grown chiefly from pieces of stem ("joints" of cane), and in certain districts (such as the red soil districts of the uplands), ratooning is practised to some extent. The date of planting a new crop of plant canes from cuttings is usually about November, i.e., towards the end of the rainy season. The plants require about 18 months to reach maturity, so that the time of reaping lies in the months of March to July in the year but one after that in which the canes were planted.

It is possible and customary to weed cane-fields in Barbados up to the end of the seventh month after the date of planting. The operation is made troublesome, however, by the presence of "trash" (i.e., dry cane leaves) which is spread over the ground at the expiration of three or four months from the time of planting, to prevent excessive loss of soil moisture. At the trashing period (January to March), plant-canes are generally about one to two feet tall, and have reached the critical period in their growth, since dry weather prevails in these months and danger from drought is not inconsiderable. It is a matter of some surprise that in Barbados young cane plants can successfully live through the dry season, especially during certain years in which the rainfall is abnormally low. The explanation of the fact might more reasonably be sought in the peculiar condition of the sub-soil and of the underlying spongy and porous coral-rock (which undoubtedly store up much water in the rainy season, and yield it up again by capillarity in the dry season), than in the drought-resisting propensities of the cane plant. No doubt, also, the occasional showers that fall during January and February assist the cane plants in tiding over the dry season.

Manuring with artificial manures is carried out in Barbados at the commencement of the rainy season (in April to June). Soon after this date, the canes are of such a height that efficient weeding becomes impossible.

From the above account it is clear that, so far as the weeds are concerned, the vegetative season in a Barbados cane-field consists of two distinct periods:—

(A) *the first*,—extending from the date of the planting of the canes (in November) up to the time when the land can no longer be weeded (i.e., up to July of the next year);—a period of about eight months' duration;

(B) *the second*,—extending from the end of the weeding time to the date of reaping of the canes (in March to July);—a period of 9 to 12 months' duration.

(A) CANE-FIELD WEEDS OF THE FIRST PERIOD.

During this period the weeds are exposed to an oft repeated turning over of the surface soil, and to frequent mutilation by the hoe of the weeder. It is not surprising, therefore, that only few plants of a certain kind can survive

such drastic treatment, and can become sufficiently well established between the visits of the weeder to make themselves conspicuous on cane-fields. As an offset to this hindrance to growth, one must bear in mind that the soil of cane-fields during the first period is in good condition and is "open", i.e., it is not occupied by the root-systems of well-grown plants as it is when the canes are mature. It is also unshaded by the stems and leaves of well-grown cane-plants.

A study of the characteristic features of the weeds in the appended list will indicate why these plants are able to persist in cane-fields:—

(i) In the first place all of them are prostrate herbs which are enabled to survive in the very earliest stages of their growth (when their root systems are still of small extent), because their leaves are spread close to the ground where the air is moister, and also partly perhaps because of their shading effect on the surface soil immediately below them, which minimises the removal by evaporation of moisture from the shallow surface-layer in which the soil roots are embedded.

(ii) Secondly, the weeds are quick-growers especially as regards their root-systems. They are mostly annual plants and reach their flowering periods in the space of a few months or even a few weeks.

(iii) Thirdly, many of them possess underground parts which can never be completely removed from the soil, and which are capable of giving rise to new shoots by a process of budding. Frequently, the sub-aerial stems themselves if broken off and left in the soil can take root and produce new plants.

(iv) Finally, all the weeds possess efficient and rapid means of dispersal, usually by wind. They can thus gain access to the freshly exposed soil of new cane-lands.

The following are the chief weeds of cane-fields during the first period:—

1. *Cyperus rotundus* (Cyperaceae) "Nut Grass."

This is perhaps the most pernicious and most prevalent cane-field weed in Barbados. It is said to have been introduced into the Island (and into other West Indian Islands) by human agency. It is a prostrate grass-like plant with quick and deep-growing, fibrous, underground stems (rhizomes), which bear numerous small tubers. This habit accounts for the success of the Nut Grass in cane-fields, since weeding only removes the green part of the plant, and leaves most of the underground parts in the soil. These latter may be inverted by the hoe, but soon the tubers bud out, and quickly produce new green shoots again. The Nut Grass has erect triangular stems (of height up to 10 inches) and flat leaves. The inflorescence consists of a cluster of spreading flattened spikelets of unequal length. The seeds are very small and wind-disseminated. They may serve in the rapid distribution of the plant over cane-fields during favourable weather.

2. Certain true grasses (Gramineae), such as:—
Cynodon dactylon, Devil's Grass, Bahama Grass.
Panicum prostratum
Panicum colonum, Palister grass.
Chloris radiata
Andropogon pertusus (=*Amphilophis intermedia* var. *acida*) Sour grass.
Bouteloua bromoides. Bird Grass.

Most of these prostrate grasses have already been described under "Plants of dry pastures." They have similar habits of growth, and reproduce themselves chiefly by underground rhizomes, which are very difficult to remove, and which are only turned over during weeding and not destroyed.

The seeds are small and wind-disseminated, and doubtless distribute the grass-species over wide areas.

3. *Commelina nudiflora* (=*cayennensis*) (Commelinaceae) Pond Grass.
This is not a true grass. It bears small flowers with bright-blue petals. The stem is creeping, slender, soft and green. It bears occasional roots at the nodes. The leaves are small (1 or 2 inches long, by ½ to 1 inch broad), and possess sheathing, tubular leaf-bases. The fruit is a small capsule of three chambers with 1 or 2 seeds in each. The Pond-Grass is a very pernicious weed in the cane-fields of the more rainy upland districts of Barbados, but it is not so common in dry lands. It is a quick grower, and is reproduced probably both by pieces of stems and by seeds.

4. *Euphorbia prostrata* (Euphorbiaceae) Milkweed. Poverty Weed.
A small prostrate plant, consisting of several slender stems arranged radially round the top of a very long main root. The stems bear small roundish leaves pressed close to the ground, and also numerous tiny flowers, which give rise to capsules containing seeds. The stems and leaves are reddish in one variety, (Reedweed) and green in another (less common) variety. The Milkweed is a very quick grower, especially as regards its root system, and, by producing large numbers of microscopic wind-disseminated seeds, it multiplies rapidly in cultivated ground, which offers little resistance to the downward growth of its roots.

5. *Euphorbia hypericifolia* (Euphorbiaceae) Milkweed.
Similar to the above, but not quite prostrate. The more or less erect stems grow to a height of 2 feet. The leaves are larger than those of *E. prostrata,* and the small flowers are arranged chiefly in terminal bunches.

6. *Pectis humifusa.* (Compositae) Duckweed.
Occurs also on the sea-shore. A prostrate mat plant with long main root, fairly common in dry sandy cane-fields. It possesses small hairy fruits.

7. *Portulaca oleracea* (Portulacaceae) Purslane.
A prostrate plant, already described. (See "Plants of dry pastures"). The broad-leaved form is common in cane-fields, especially when the soil is dry and sandy. It is chiefly disseminated by its tiny seeds.

8. *Tribulus maximus.* (Zygophyllaceae).
A prostrate plant which is perhaps more frequently seen in neglected gardens than in cane-fields. It possesses several stems which radiate from the summit of a deep-rooted tap root. The stems are pinkish in colour, and may grow to a great length. The leaves are bipinnate, consisting usually of 3 pairs of leaflets of length ½ inch. The flowers are pale yellow, cup-shaped, and of diameter ½ inch. The fruit splits into 4 to 6 parts when ripe.

9. *Rhynchosia minima.* (Leguminoseae,—Papilionatae) Burn-mouth Vine.
A small prostrate leguminous weed. Common also on dry pastures.

10. *Ipomea dissecta.* (Convolvulaceae).
A twining plant (already described under "Mesophytes of gullies") which frequently trails on the ground when no support is available. It is not a very common weed on cane lands, but is occasionally found in moist places.

A few other weeds make their appearance in cane-fields as seedlings. They are usually easily removed, although several individuals always escape the observation of the weeders and continue to exist so as to become characteristic weeds of the second period of growth to be described next.

(B) CANE-FIELD WEEDS OF THE SECOND PERIOD.

During this period, the weeds are undisturbed in the soil, since weeding can no longer be performed because of the large size of the cane plants. The presence of well-developed canes, however, at the same time, places certain restrictions on the vegetative activity of the weeds of cane-fields during the second period. These restrictions counteract the advantage which the weeds enjoy over those of cane-fields subjected to the hoe of the weeder. For instance, the soil of the fields is fully occupied by the abundant roots of the cane plant which, being surface-feeding and wide-spreading, makes it almost impossible for all but a few plants to produce their normal root development. Further, the tall cane plants cut off much light from those weeds which are growing in their vicinity. They also alter other atmospheric conditions of growth, in that they shelter the weeds from wind. The result of this is that the air near the soil in fields of mature canes is humid and quiet;—factors which exert their effects in deciding what kinds of plants will eventually constitute the weed flora of mature cane-fields.

It should be borne in mind that the number of individual plants that may survive the persistent weeding of the first period is bound to be small. Further, only those survivors possessing certain characteristics are able to succeed in competition with the vigorous cane plant.

The prostrate plants which have been able to tide over the first period, will most probably be exterminated by the "smothering" effect of the rapidly growing canes, and of the dead leaves (trash) which cover the soil during the second period.

The plants included in the following list should therefore be studied from the point of view of the effect of these various factors.

(i) In the first place, the weeds in the list are chiefly climbing plants belonging to the family Leguminoseae. They make use of the cane plants in spreading their leaves to the subdued light which occurs within the dense tangle of leaves and stems of closely growing mature canes. Their stems are weak and exhibit long internodes.

(ii) Secondly, they possess leaves admirably suited for the peculiar conditions of their habitat. The leaves are large and thin, and are not protected for resisting the harmful effects of intense light, or for checking rapid transpiration. There would be no advantage in such protection, since the light reaching the leaves is diffused and of low intensity, and since the environment is such that evaporation is minimised and water supply abundant. In short, the climbing weeds of fields of mature canes are typical shade plants. Specimens collected when the canes are being cut show great luxuriance of growth.

(iii) A few erect herbs which are not climbers occasionally survive the exacting conditions of growth in mature cane-fields. These also have large thin leaves, but are usually lanky, because of the effect of light of small intensity.

(iv). Most of the weeds possess extensive root-systems consisting of a long tap-root, with numerous branching roots that ramify between the fibrous roots of the canes.

The following are the chief weeds of cane-fields during the second period:—

(a) **CLIMBERS.** (Leguminoseae—Papilionatae).

1. *Teramnus labialis.* (similar to *T. uncinatus*), Rabbit Vine.
(See under "Plants of dry pastures"). The plants of this species found in mature cane-fields grow luxuriantly and develop the twining habit typically. Their leaves are larger than the stunted related species of dry pastures. The vines often reach great length, and the flowers and fruits are produced in profusion.

2. *Phaseolus semierectus.* Wild Dolly, Kidney Bean.
An annual plant with stems erect at the base, and twining above. The leaves are trifoliate. Each of the three leaflets is ovate, and of length about 2 inches. The leaves are thin, bright green, and covered with fine silky hairs. The flowers are borne in long racemes with a much elongated stalk to the inflorescence. The flower is deep purple in colour. The fruit is a narrow curved legume of length about 4 inches, containing often as many as 20 small seeds.

3. *Vigna glabra* (=*luteola*), Yellow Vigna, Rouncival Bean, Monkey Pea.
A plant similar in habit to the above and possessing similar leaves. The flowers are of a bright yellow colour. The fruit is a narrow legume of length about 2 inches and contains about 10 small pale-brown seeds.

4. *Mucuna pruriens.* Cow-itch.
An annual twiner, with slender hairy stems and trifoliate leaves. The leaflets are ovate, and are often 3 inches or more in length. They are thin and slightly hairy. The flowers are borne in short racemes in the axils of the leaves. The fruits occur in clusters. They are hard yellow-brown pods, covered with a dense layer of hairs, which are intensely irritating when they break off and penetrate the skin of animals. The pod is oblong, of length 2 inches, and shaped somewhat like a letter S.

(b) ERECT HERBS.

It is very unusual to find specimens of erect herbaceous weeds in cane-fields. Those individuals that survive the period of weeding are generally quickly suppressed by the vigorously growing cane plants. Occasionally, when the canes are being cut, one might come across a specimen of some erect herb, which usually shows lanky or otherwise abnormal growth. Such weeds can be recognized as escapes from the plant community that inhabits the waysides of roads and paths near the canefields. The commonest amongst them are hardy, quick growing, rapidly-disseminated annual plants such as certain Compositae, Labiatae and Verbenaceae. They will be described or mentioned when the plants of waysides are considered.

(2) PLANTS OF PERMANENT PASTURES. (MEADOW WEEDS)

CHAPTER XV.

In the chapter on the Mesophytic Associations of Barbados, an account was given of the pure plant association of the dry pastures, and, as a preface to that account, mention was made of the existence in the Island of numerous permanent pastures, (which should more strictly be termed meadows), in which the chief grass is either Sour Grass, Guinea Grass or Para Grass. It is now intended to consider the vegetation of these pastures in turn, beginning with Sour Grass pastures which constitute the main pastures of Barbados.

(A) PERMANENT PASTURES (MEADOWS) OF SOUR GRASS.

Most sugar estates of Barbados possess one or more fields which were originally planted in Sour Grass, but which have rarely or never been manured since the original planting. The planting was done in the first place by spreading short pieces of Sour Grass stems over ground which had in most cases previously been under sugar cane cultivation, and then covering the pieces with a thin layer of soil. As will be gathered from its past history, the soil of Sour Grass fields is, therefore, frequently of considerable depth, and by reason of its previous tillage and manuring, it is more retentive of water than soil of uncultivated districts.

Sour Grass is generally cut twice or three times during the year, and animals are seldom, if ever, allowed to graze on it whilst it is growing. Hence the Barbados Sour Grass pasture might more correctly be termed an unmanured Sour Grass meadow, and might thus be compared with certain meadows of temperate regions such as Europe and North America.

It is a noticeable fact in the Barbados Sour Grass pastures, that, in spite of neglect, the vegetation is surprisingly pure. The number of weeds that occur along with the Sour Grass is exceedingly small;—a state of affairs which can be obtained in meadows of temperate countries only by rigorous and systematic weeding, and by the employment of the purest manures.

The appearance of a field of Barbados Sour Grass is very uniform. The colour, in mass effect, is a bright yellowish-green, except when the grass is in flower, when the dark-red inflorescences naturally affect the general tint. The freshness of the Sour Grass fields is a characterictic of the landscape of the flatter parts of the Island. It is difficult to explain convincingly why Barbados Sour Grass pastures are so pure and free from weeds. The chief reason is perhaps the vigorous growth of the grass, which makes it almost impossible for other plants successfully to compete with it.

DESCRIPTION OF THE BARBADOS SOUR GRASS.

(*Andropogon pertusus*=*Amphilophis intermedia* var: *acida* sp. nov: Stapf, 1916) (See under "Food plants").

The Sour Grass is a perennial plant, growing to a height of 2½ feet. The underground part of the plant is a short rhizome, which bears numerous adventitious roots. The subaerial stems are tufted, and are usually more or less prostrate at the base. The prostrate part of the stems generally gives off rootlets at the nodes. The leaves possess short sheathing bases, and fairly long linear blades, (of length 3 to 8 inches and breadth ⅛ to ¼ inch). They are almost quite smooth. The inflorescence is a panicle, consisting of a primary axis (of length up to 3 inches), which bears several (10 to 15) horizontal racemes of spikelets of flowers.

WEEDS OF SOUR GRASS PASTURES.

There are two conspicuous weeds which occur persistently in Barbados Sour Grass pastures. They are:—

1. *Crotalaria retusa.* (Leguminoseae,—Papilionatae), Yellow Sweet-pea. An erect plant, with woody stem bases. The plant grows up to height of 2 feet, and usually possesses many branches. The leaves are single and spatulate in shape, green and smooth above, and whitish and downy beneath. The inflorescence is a many flowered raceme, the papilionaceous yellow flowers being about 1 inch long. The fruit is a cylindrical black dehiscent pod, 1½ inches long, containing numerous small, kidney-shaped seeds, which shake about loose in the pod before dehiscence. The plant is very common throughout the West Indies. In Barbados it is commonest in those Sour Grass fields which occur in the lowland black soil districts.

2. *Cassia polyadena.* (Leguminoseae—Papilionatae). Wild Tamarind. A perennial plant, woody, erect, but possessing few branches. Height up to 2 feet. The leaves are pinnate, with 4 to 8 leaflets, each of length about ¾ inch, and breadth ⅜ inch. The flowers are yellow, and of length 1 inch. They are borne singly or in pairs in the leaf-axils. The fruit is a narrow, thin, dark-brown, dehiscent pod of length 1 inch. The Wild Tamarind characterises the Sour Grass fields of the red soil (upland) districts of Barbados, rather than those of the black soil (lowland) regions.

The reason why these two weeds are able to compete with the vigorous Sour Grass, whereas few other wild plants are ever successful is difficult to understand. The seeds of both weeds germinate easily and the tap roots of the seedlings are abnormally long and quick-growing. These characteristics might allow rooting in the layers of soil below those occupied by the shallower rooted grass, thus preventing competition. It must be admitted, however, that there are many other weeds in Barbados (along waysides etc.) which also possess the root-characteristics exhibited by *Crotalaria* and by *Cassia polyadena*, but which are nevertheless rarely seen growing in Sour Grass fields.

Other weeds of Sour Grass fields of much less importance than the above, and of infrequent occurrence, are the leguminous, erect plant, ***Desmanthus depressus*** (along with a few other erect plants, already mentioned or described under the heading "Dry pastures"), and certain procumbent or prostrate leguminous plants, such as *Teramnus uncinatus* (Rabbit Vine); *Desmodium* spp. (Sweethearts); *Rhynchosia minima* (Wild-pea Vine), which also belong to the flora of dry pastures.

(B) PERMANENT PASTURES (MEADOWS) OF GUINEA GRASS.

There are a few unmanured meadows here and there in Barbaods in which the chief grass is Guinea Grass (*Panicum maximum*). Many of these meadows occur in or near Bridgetown, and occasionally on the sugar estates of the Scotland District along the sides of water courses. Guinea Grass meadows are never extensive in Barbados. They are usually small plots of grass grown for fodder for horses chiefly. They exhibit one or two features of botanical interest worthy of brief consideration.

DESCRIPTION OF GUINEA GRASS.

Panicum maximum—(See under "Food plants").
A perennial grass of tufted habit, growing up to a height of 2 to 5 feet. (It is stated that, under cultivation, Guinea Grass may reach a height of 12 feet, but, although this height may be attained in other Antillean Islands, it is never attained by Barbados Guinea Grass. The stem is erect, stout and straight. There is a short underground rhizome. The inflorescence is a loose panicle of length 4 to 12 inches. Inflorescences are produced prolifically in the wet season.

WEEDS OF GUINEA GRASS PASTURES (MEADOWS).

These consist of small prostrate herbs, climbing herbs and erect herbs. The small prostrate herbs and the erect herbs, include many of the species found in dry pastures. It is to be noticed that the weeds of Guinea Grass plots include few or no grasses. The erect herbs are mostly woody, as in the case of dry pastures.

The chief feature of the weed flora of Guinea Grass pastures is the presence in them of numerous, slender climbing plants, which twist by means of tendrils up the tall stems of the grass, or of the erect weeds.

The chief of them are:—

1. *Passiflora foetida* (Passifloraceae) Love-in-a-mist.
   Climbs by axillary stem-tendril.

2. *Peponia* Sp. (Cucurbitaceae). Wild Cucumber.
   Climbs by means of tendrils, of which the true nature is not clear.

3. *Ipomea pentaphylla.* (Convolvulaceae).
   Climbs by twisting round its support. The leaves of this plant are 5-lobed. The stems and leaf-petioles are covered with long yellow hairs. The funnel-shaped flowers are white.

These climbers occur also in gullies and are more fully described under "Mesophytes of gullies."

(C) PERMANENT PASTURES (MEADOWS) OF PARA GRASS.

These are of less frequent occurrence in Barbados even than Guinea Grass meadows. Para Grass grows properly only in well-watered situations, and is found almost exclusively in the upland districts of Barbados, in bottoms or hollows where water tends to accumulate, and where soil cultivation for cane-growing is difficult. Para Grass is also fairly common near water courses in the Scotland District estates.

DESCRIPTION OF PARA GRASS.

Panicum muticum—(see under "Food Plants").
A perennial tufted grass, which, unlike Guinea Grass, possesses a more or less prostrate habit. The underground rhizome is short, and the stem bases are frequently rooted at the nodes. The inflorescence is similar to that of Guinea Grass.

WEEDS OF PARA GRASS PASTURES (MEADOWS).

These are not numerous nor of especial interest. A certain number of weeds which grow best in moist soil are able successfully to compete with Para Grass. Examples are:—*Spigelia anthelmia* (Water Weed), and a few other erect herbs:—*Commelina nudiflora* (Pond Grass), and certain other prostrate

plants, (including leguminous creepers), and occasionally sedges such as *Cyperus rotundus* (Nut Grass), together with other *Cyperus* species, and species of *Fimbristylis.*

(3) PLANTS OF CERTAIN WASTE PLACES.

CHAPTER XVI.

Besides the natural waste places already considered in Chapter XII, there are other waste places in Barbados where the conditions of plant growth have been somewhat influenced by man.

In many parts of Barbados where coral limestone is being quarried for use in building, lime-manufacture or road-making, or where marl is being removed for agricultural or other purposes, the exposed substratum quickly becomes populated with vegetation of a fairly well-marked type. Vegetation of a similar nature is also found growing on debris heaped up near building sites, or near places where excavations or levelling operations are, or have been, going on.

The conditions of growth in such habitats are sufficiently distinctive as to prohibit the establishment of all but a few species of plants, at least in the early stages of colonisation. The substratum itself is highly calcareous, and contains an extremely small amount of organic matter. The water supply varies. Usually, because of the porous and retentive nature of the coral material, it is quite good. The soil water is generally fairly rich in nutrient salts. These characteristics of very chalky soil considered along with other incompletely understood physical and chemical properties, seem to satisfy the requirements of plants of a certain type. In many countries of the world, plants that thrive vigorously on chalky soil have been investigated, and lists of their names compiled. Many true chalk or limestone plants are thus known to botanical science, and it is possible that the plants to be named below might also belong to this class.

It will be noticed that the plants possess few obviously similar and distinctive characteristics, except perhaps that they are all quick growers, and produce great numbers of small seeds. This latter characteristic might have value in ensuring that a good number of the seeds at least reach situations favourable for germination.

The chief plants growing commonly in old quarries, marl pits, and on chalky debris in Barbados are:—

1. *Argemone mexicana.* (Papaveraceae). Mexican Thistle, Yellow Poppy.
   An erect annual herb of height about 2 feet, having greyish wax-covered leaves and stems. The plant contains yellow bitter juice. The leaves are deeply divided, and possess numerous spiny teeth. They have conspicuous whitish leaf-veins. The flower is large and yellow; its petals are thin and drop easily. The fruit is an erect capsule which, when dry, allows its seeds to be sprinkled out through holes near its summit as the wind shakes the plant. *Argemone* is not indigenous to Barbados, but was introduced into the West Indies inadvertently along with seeds of cultivated crops, from Mexico. It is a common weed, not only of chalky ground, but also of certain dry pastures and neglected

cultivated peasant-plots in all parts of the Island. It is found on waste-lands in all tropical countries.

2. *Leonotis nepetaefolia* (Labiatae) Lion's Tail.
A common erect annual herb. It is a very quick-growing plant, with a deep tap-root system. The stems are square, and of height up to 3 feet. The leaves are large, oval, crenulate and possess long petioles when mature, so that the young leaves do not shade the old. The most conspicuous part of the plant is its straight inflorescence axis, which bears several globular clusters of flowers or fruits with spiny calyces at distances of 6 inches to 1 inch apart. The flowers protrude from the younger green clusters. They are two-lipped, and orange in colour. The fruits are brown, membranous and very spiny. They contain each several small black seeds. *Leonotis* is a common weed of ubiquitous occurrence in Barbados.

3. *Boerhavia hirsuta* (=*repens*) (Nyctaginaceae). Hogweed.
A loosely-branched herb of height 2 feet, with somewhat trailing, long slender stems, which are dark coloured and slightly hairy. The leaves are more or less oval, and of length about 1 inch. The flowers are tiny, of a blood-red colour, and are arranged in panicles. The fruit is a small club-shaped capsule of length ⅛ to ¼ inch. It is covered with glandular hairs, which cause it to adhere to animals. The Hogweed is also common in dry pastures.

4. *Achyranthes aspera.* (Amarantaceae)
A herb with woody base and low branches. The leaves are elliptical, pointed, and of length 1½ to 3½ inches. The flowers are very tiny, and are arranged along a lengthy slender axis. The flowers soon give rise to small dry fruits (length ⅛ inch), which possess each four backwardly-directed spines. The spinose fruits are easily disseminated by animals and passers-by. *Achyranthes* is a common erect plant of dry pastures.

5. *Gynandropsis* (*cleome*) *pentaphylla.* (Capparidaceae). Stinking Miss.
An erect annual herb, of height up to 3 feet. The leaves consist each of five elliptical leaflets attached to the end of the leaf-stalk. The flowers are arranged in terminal leafy racemes. Each flower has 4 small white petals and 4 stamens arranged at the end of a slender stalk. The ovary also is borne on a special stalk. The fruit is a narrow dry capsule of length 2 inches. It dehisces by 2 valves, and leaves the small seeds attached to a frame work from which they eventually drop to the ground. The crushed leaves emit a disagreeable odour.

6. *Lepidium virginicum.* (Cruciferae). Wild Cress, Pepper Grass.
An erect annual herb of height up to 1½ feet. It is much branched above,—the branches terminating in floral racemes. The leaves are narrow, and of length up to 3 inches. The flowers are very tiny, and possess each 4 white petals. The fruits are flattened, dry, heart-shaped structures, of length ⅛ inch. They are very numerous, and form the most conspicuous feature of the plant.

Besides the above, certain other less typical plants, many of which have already been described or mentioned, occur in recently exposed chalky localities, or on heaps of debris. The chief are:—*Cenchrus echinatus* (Burr Grass); *Eragrostis ciliaris* and *E. purshii* (tufted grasses); many members of the family Compositae, and a few hardy plants of other families.

As the substratum becomes disintegrated by weathering, and as the addition of the dead remains of the first-established plants gives rise to true humus-containing soil, the waste places gradually become able to support a more varied and luxuriant flora. Perennial plants begin to appear, and finally certain shrubs and trees. The following plants have been observed to populate such mature sites. *Jatropha gossypifolia* (Belly-ache Bush); *Clerodendron aculeatum* (Wild Coffee); *Tribulus maximus* (a woody prostrate herb of the family Zygophyllaceae); *Sida* spp; *Capraria biflora; Waltheria americana* (Buff Coat); many grasses; certain creepers, such as *Momordica charantia* (Cucurbitaceae); *Cardiospermum halicacabum*, (the last two already described under "Climbing herbs of gullies"), and the shrubby trees *Leucaena glauca* (Mimosoideae); *Pithecolobium unguis-cati* (Bread-and-cheese); and *Zizyphus jujuba* (Dunk).

(4) PLANTS OF CERTAIN WAYSIDES.

CHAPTER XVII.

The vegetation of the waysides of Barbados at first sight would appear to be particularly uninteresting, but their botanical investigation, in the light of foregoing considerations, reveals endless ecological problems.

The waysides of Barbados may be divided into several groups, as follows:—

A. Waysides of the main high roads skirting cane-fields in the coralline parts of Barbados.

B. Waysides that consist of an almost vertical rocky wall.

C. Roads and paths separating cane-fields (including also roads of the Scotland District).

D. Waysides of the streets of Bridgetown, and of the larger villages.

These groups merge imperceptibly into one another in places, but, on the whole, they are fairly well-defined. The manner in which man has been instrumental in determining the nature of the wayside flora, has already been described in Chapter VII. It was there concluded that the habitats of certain wayside plants of Barbados owe several of their features (such as depth and nature of the sub-stratum, position as regards light and exposure to interference by animals and man), to the fact that they owe their origin to human agency. The relative importance of man's influence as an agent governing the distribution of plants in the habitats offered by the different types of wayside will be made clear when each type is considered.

(A) WAYSIDES OF HIGH ROADS IN THE CORALLINE PARTS OF BARBADOS.

The high roads of the coralline region of Barbados are numerous, and, on the whole, well-kept. They are bordered for the most part by cane-fields, and probably owe their frequently tortuous course to the fact that they were originally built to skirt the cane-fields. It is a noticeable feature that most of the high roads are sunk below the level of the cane lands on either side. This is probably due to the wear and tear of their surfaces, and to the rolling they have received during repair. The roadside thus consists typically of a bank of height usually one to four feet, which generally has a gutter or trench at its base.

We may consider first the vegetation of the wayside bank, and afterwards, that of the gutter.

(1) THE WAYSIDE BANK.

The bank is usually rocky and very irregular. It is often almost vertical, seldom inclined at an angle of less than 45 degrees. Here and there bare rock protrudes, but in the hollows, pockets and crevices soil occurs in sufficient quantity to support a fairly prolific vegetation.

The soil is usually cane-field soil, which has fallen down from the cultivated land above. It is thus rich in organic matter and in nutrient salts, and is in good tilth. Further, because of its position, the soil of the bank is well drained. The surface of the bank is generally exposed to the sun's rays, since shrubs are usually absent from its summit, and the cane-plants on the land above are only tall enough to give much shade for a small part of the vegetative season. In the deeper pockets of soil, the water supply may be fairly abundant, by reason of the gradual passage into it of water stored in the porous and retentive coral rock, which comprises the foundation of the bank. The depth of the soil varies, therefore, from place to place on wayside banks, and the vegetation varies accordingly in their different regions.

Growing in the shallower pockets of soil, and almost on bare rock itself, one finds rocky land xerophytes such as the Sages (*Lantana involucrata, L. camara, Cordia cylindristachya* and *Croton flavens*); *Psidium guajava* (Guava); *Jatropha gossypifolia* (Belly-ache Bush); *Pedilanthus tithymaloides* (Laurel-leaved Spurge); &c.

The deeper pockets support a grassy flora, which is often rank and vigorous. The grass most commonly present is the Sour Grass (*Amphilophis intermedia*, var: *acida*), although other perennial grasses, such as the Devil's Grass (*Cynodon dactylon*) and, occasionally, annual grasses also occur. Along with the grasses, several erect perennial herbs abound. The chief of these are *Stachytarpheta indica* (Vervain); *Cassia polyadena* (Wild Tamarind); *Crotalaria spp.* (Sweet Peas); *Desmanthus depressus; Blechum Brownei; Corchorus siliquosus* and *Miconia laevigata*. Frequently erect annuals occur also,—*Euphorbia* spp. (Spurges); *Spermacoce* (=*Borrera*) *laevis;* and certain Compositae and Labiatae may also be cited as examples. Finally, several creeping or climbing plants grow amongst the grasses and the erect herbs, or sprawl over the bank. The commonest are—

Wedelia gracilis (Compositae—a prostrate creeper); *Vitis sicyoides* (Poison Withe); *Ipomea spp.* and *Passiflora foetida* (Love-in-a-mist).

From the above account, it might be concluded that the flora of typical roadside banks approximates closely to a mixture of certain xerophytic rocky land-plant types and certain dry pasture types. In so far as it consists chiefly of perennial plants which are well-established in the sub-stratum, the bank flora certainly does resemble such a mixture of associations.

The chief characteristic is the relative luxuriance of the growth of the perennials, grasses and other herbs as compared with those of typical dry pastures;—a fact partly to be explained by the more abundant water supply of wayside bank-habitats, and partly by the general absence of the check to growth imposed on vegetation subjected to the attacks of grazing animals.

(2) THE WAYSIDE GUTTER OR TRENCH (AT THE BASE OF THE BANK).

The plants growing here differ markedly from those of the bank since the conditions of growth in the two regions are very dissimilar. In the first place, the sub-stratum of gutters is not composed of good soil in most cases, but of a mixture of soil which has fallen down from the bank above and road dust, &c., which has collected in the gutters especially during windy weather. The soil is not usually very deep, and its water supply is intermittent. In the rainy months, the gutter may contain abundant moisture, and plants might thrive luxuriantly in it. On the other hand, in the dry season, the gutters are parched and dusty, and the plants are often almost completely desiccated. A still more important factor is the repeated extermination and mutilation to which the gutter-plants are subjected by the hoes of weeders. These weeders are sent out by the Highways Boards Authorities almost every day, and every high road in the Island is supposed to be cleared of gutter-plants at least twice a year.

It is thus evident that the conditions of life of plants that start growth in wayside gutters or trenches are very precarious. Nevertheless, a certain number of plants manage to succeed in spite of difficulties. Their characters are well worthy of investigation.

At the outset one notices a resemblance between the set of factors that operate in wayside gutters and those that operate in cane-fields during the first period of growth when the fields are being weeded. One would, therefore, expect to find the same sort of plants inhabiting gutters (especially just after they have been cleaned) as appear on weeded open cane-lands. Observation shows this actually to be the case. The prostrate plants already described under "Plants of cane-fields" frequently occur in wayside gutters. Indeed, they are the first to make their appearance there. Later, other annual plants become established, but perennials seldom appear, since their growth is, generally speaking, slow, and they are not allowed sufficient time between the weeding periods in which to produce seeds. Thus the characteristic plant community of wayside gutters is composed chiefly of quick-growing annual herbs, which possess ready means of spreading.

In addition to the plants listed under the heading "Cane field weeds of the first period" which include several grasses and prostrate plants (especially *Euphorbia* spp.), the following species are commonly found in wayside gutters. They mostly belong to the family Compositae, a family which, perhaps, represents the high-water mark of efficiency in adaptation to various habitats, and in rapidity of seed dispersal.

Compositae.

1. *Vernonia cinerea.*
   An erect, much branched, deep-rooted, annual plant, growing up to a height of one to two feet. It possesses oval leaves and pale-lilac flowers arranged in small close heads. The tiny fruits are furnished with white hairy parachutes, which aid in their dispersal by wind.

2. *Parthenium hysterophorus* Whitehead.
   An erect much-branched, deep-rooted annual plant with small dissected leaves, and very numerous small white pentagonal heads of flowers. Its fruits are small, and are either devoid of hairs or possess only few of them.

3. *Emilia sonchifolia.* Red Groundsel, Paint Brush.
   An erect, deep-rooted annual plant with fairly large, irregular arrow-shaped leaves which clasp the stems at their bases. The heads of flowers are pale-red in colour, and the small fruits are provided with parachutes of hairs.

4. *Eclipta alba.*
   Similar to the above in habit, but possessing dark-green stems and leaves, and green, disc-like heads of flowers. The fruits are tiny, but devoid of hairs.

Other species of Compositae occur occasionally in wayside gutters. The chief are:—

Erigeron spathulatus and *E. canadensis* (which have parachute-like, hairy fruits); *Lagascea mollis* (Velvet Bush) and *Ageratum conyzoides* (which have bare fruits); *Elephantopus spicatus; Synedrella nodiflora* (Porter Bush) and *Bidens pilosa* (having spiny fruits which adhere to the legs of animals).

The following quick-maturing annual plants with rapid means of seed dispersal, also commonly occur in gutters, especially when these are moist or shady, and are left undisturbed for some time:—

Fleurya aestuans (Nettle); *Amaranthus viridis* (Pig Weed); *Priva echinata* (Velvet Burr); *Heliotropium indicum* (White Clary); *H. parviflorum* (Eyebright); *H. curassavicum* (Wild Lavender); *Euphorbia pilulifera; E. lassiocarpa* (Spurges); *Ocimum micranthum* (Wild Basil); *Hyptis capitata* (Wild Hops); *Leonurus sibiricus* (Siberian Motherwort); *Spigelia anthelmia* (Water Weed); *Spermacoce (=Borrera) laevis; Chenopodium ambrosiod*es (Wormwood); *Portulaca oleracea* (Purslane); and *Isotoma longiflora* (Star of Bethlehem).

Finally, when wayside gutters are left undisturbed, and never cleared of weeds, they gradually fill and their vegetation slowly changes to that of a more or less dry pasture type, with a preponderance of perennial plants. These perennial plants oust the annuals from the habitat because they possess more effective methods of vegetative propagation, and are able to tide over periods of drought by means of their persistent underground parts or their resistant woody stem bases.

(B) WAYSIDES WHICH CONSIST OF AN ALMOST VERTICAL ROCKY WALL.

Two fairly distinct kinds of rocky walls bordering roads of Barbados may be recognised—

(1) Rocky walls which have been produced artificially by cutting roads through terraces (in order to reduce the steepness of the road surfaces) in the limestone districts of the Island. Usually both sides of the road are bordered by cliffs of this sort.

(2) Rocky walls which have existed naturally from the earliest times, and alongside of which roads have been constructed so as to skirt them. Usually only one side of the road is bordered by such cliffs. The two kinds may be considered separately.

(1) ARTIFICIAL ROADSIDE ROCKY WALLS.

In the last section the commonest kind of waysides in the coralline parts of Barbados was considered. The waysides of that type were described as consisting of rocky banks with gutters, ditches or trenches at their bases, and it was assumed that they had been formed by the gradual wearing down of the road surface by traffic, so that the cane-lands on either side now stand at a level on the average of about 4 feet above the road surface.

In certain places, the roads have been cut through terraces of all sizes and steepness, so that the roadsides here consist of almost vertical walls whose height varies from a few feet to 30 feet or more. Being of comparatively recent origin, the faces of these walls have not usually undergone much weathering, so that they are not very deeply pitted. There are thus few sites on the actual rock-face suitable for the establishment of a definite flora. Further, many of them are exposed to the sun and wind so that moisture conditions are poor. Occasionally ledges occur at different levels on the cliffs. These sometimes support a vegetation of xerophytic plants of a type very similar to that found on certain inland rocky cliffs, and sometimes also of other plants, such as grasses. The summit of the walls generally presents a similar habitat as the ledges, and here also xerophytic and other plants often occur. These plants gradually merge into the plants of the fields or waste land at the top of the roadside cliff.

At the bases of many of the rocky walls, shallow ditches or hollows occur. These have either been worn out by water during periods of heavy rainfall, or have been dug by the road makers for the purpose of drainage. In either case

they support a flora which resembles in every respect that already described in the last section.

It is common to find certain characteristic plants growing out from the lower parts of the walls of roadside cuttings. The chief of them are described below. They seem to require fairly abundant water in order to flourish properly. This they apparently find in the damp rock at the bases of walls. They occasionally occur also at the bases of walls of old buildings, in certain parts of gullies, or inside the shafts of wells or "sucks" of cane-fields. The lower parts of most artificial roadside walls are damper than the higher parts of the wall, by reason of the tendency of the moisture which accumulates in the spongy porous coral rock to percolate vertically downwards from the upper layers which lie immediately below the soil of the land above, and then to spread laterally, until it oozes out somewhere near the level of the road. Perhaps also the fact that water remains for some time in contact with the basal parts of the roadside walls during the wet months when the gutters contain much rain-water, permits of the soaking up of moisture by the spongy coral rock in the vicinity of the gutters, thus causing the lower layers of rock to be permanently damper than the upper layers.

The commonest of the plants which grow prevalently on the moister rock near the base of many road cuttings are:—

1. *Pteris longifolia* (Polypodiaceae-Filicineae). Common Wall-fern.
   The fronds of this fern are of length ½ to 2 feet. They consist each of numerous lateral leaflets, and terminate in a long leaflet, which forms a conspicuous feature of the frond. Each leaflet is of length 2 to 6 inches, and width ⅛ to ½ inch. The apex is pointed, and the margin is slightly curled (except near the apex) to protect the numerous sporangia that line the edges of the leaflet. The base of the leaf-stalk is clothed with pale-brown scaly hairs. The root-system consists of fibrous roots that grow out from a small disc-like structure to which the fronds are attached. These roots firmly attach the plant to the rocky wall.

2. *Isotoma longifolia* (Campanulaceae) Star of Bethlehem.
   A poisonous herb. Biennial or triennial. The leaves are 3 to 4 inches long, lanceolate and deeply indented. They form tufts round the short rarely-branched stem. The flowers are long, narrow and tubular, with flat, white, 5-rayed summits. Their length is about 4 inches, and the diameter of the "star" is 1 inch. The plant flowers for most of the year.

4. *Pilea microphylla* (=*muscosa*). (Euphorbiaceae).
   A delicate pale-green plant with very small and numerous leaves, and spreading freely-branched stems.

Besides the above, certain ferns (other than *Pteris*) occasionally occur on the lower parts of the walls. The dampness and shadiness of the walls decide whether or not these ferns are able to thrive. The same species as those already described in connection with the flora of gullies are sometimes represented. *Gymnogramme calamelanos* (Silver-backed Fern) is the commonest of them. Frequently also certain succulent creepers of gullies, (especially *Peperomia*

pellucida), grow on the walls when conditions are favourable. Dark green-brown velvety tufts of true Mosses also often times occur. *Funaria* sp. is the commonest of these. Finally, patches of silver-grey, yellow-brown and pale-green Lichens mottle the walls of road cuttings in all their parts, and produce a conspicuous colouration.

(2) NATURAL ROADSIDE ROCKY WALLS.

These are often of considerable height. They may not immediately border the road but may be situated some distance away from it, the intervening ground being of the nature of dry pasture or rocky waste land. The rocky walls may in certain cases merely form the sides of large detached masses of coral rock which have fallen down from neighbouring cliffs, and which have proved too big to be removed, so that the roads or paths have had to be made round them. Usually their surfaces have undergone much weathering, and deep pits or pockets occur all over them. In those districts where the rocky walls are somewhat sheltered from winds, and where the water supply is fairly good, the vegetation frequently reaches luxuriance. The pockets in the walls support the life of epiphytes, succulents and rock plants similar in assortment to those of a typical gully wall. The soil at the base of the wall is sufficiently deep and rich to support several species of climbing plants, which grow in tangled masses over the epiphytes and erect plants that are rooted on the vertical rock-face. On the basal soil grow also many erect shrubs and herbs frequently seen on the floors of gullies. Occasionally, however, the rocky faces of many road-bordering cliffs are so exposed that they are, for the most part, bare of vegetation.

(C) ROADS AND PATHS SEPARATING CANE FIELDS.

Cane-fields in Barbados are separated at frequent intervals by roads and paths which are used during manuring, reaping, &c. for the conveyance of materials or canes from or to the estate yard, and for providing easy access to the fields. The paths are not always in constant use, so that their vegetation is allowed to grow unmolested for some time.

Cane-field paths are generally rough and stony. They are green with grass and herbage. The sides of the path slope up to the cane-fields on each side, so that there is an earthy bank of exposed cane-field soil, on which many plants flourish during those times of the year when the canes are maturing, and when weeding is not being practised.

It would be advisable, therefore, to consider cane-field paths as consisting of two different regions:—

(1) The central part of the path traversed by carts, cattle, labourers, &c.

(2) The earthy banks bordering the paths.

(1) THE CENTRAL REGION OF CANE-FIELD PATHS.

This region consists usually of stony ground. The rocks of the substratum often appear through the soil, the soil varying in depth from place to place in

the path, and for that reason presenting habitats of different degrees of favourableness for the growth of plants.

The vegetation of the central region of cane-field paths would thus be expected to exhibit the same features as that of rocky waste places. Examination proves this to be the case, with one qualification, and that is that the cane-field path vegetation, although consisting of the same kinds of plants, is far more luxuriant than that of rocky waste places. The explanation of this lies in the fact that firstly, the paths are much more protected from wind than most waste places, and secondly, that the pockets of soil are generally deeper and moister than those of waste places. One frequently finds in the central regions of cane-field paths certain xerophytic rock plants such as *Lantana spp.; Cordia cylindristachya; Croton flavens* (Sages); *Psidium guajava* (Guava); *Jatropha gossupifolia* (Bellyache Bush); *Pluchea odorata* (Cure-for-all); which grow in the shallower pockets. Intermingled with these are perennial grasses, perennial herbs and a few shrubs, together with certain annual grasses and herbs which grow in the deeper soil.

Of the perennial grasses, the Sour Grass is by far the commonest in cane-field paths. It frequently grows rank and thick in patches of considerable size, especially in those paths which are seldom used, and in which the grass has had time thoroughly to establish itself. Other perennial tufted grasses such as *Sporobolus indicus* (Wire Grass); species of *Paspalum* and of *Panicum*, and in the drier places, *Cynodon dactylon* (Devils Grass) also often occur.

The most conspicuous of the perennial herbs represented in the central regions of cane-field paths other than the rock xerophytes already mentioned are:—*Stachytarpheta indica* (Vervain) and the woody-based rigid Composite plant, *Elephantopus spicatus* (Spiked Elephant's Foot). Other perennial herbs of common occurrences are—*Cassia polyadena* (Wild Tamarind); *Crotalaria retusa* and *verrucosa* (Sweet Peas); *Desmanthus depressus; Corchorus siliquosus* (Broom Weed); *Sida* spp.; *Blechum brownei* and *Walthemia americana* (Buff Coat).

Prostrate plants are not typically developed, since the conditions in the pockets of the soil are not, generally speaking, like those of the soil of close-cropped and almost parched dry pastures. Such plants as *Desmodium* spp. (Sweethearts); *Teramnus uncinatus* (Rabbit Vine) and *Stylosanthes procumbens*, whose stunted, low-lying stems constitute a carpet over the soil of typical Barbados dry pastures, are here seen to take on a more profuse growth, and in certain cases, to exhibit the climbing or sprawling habit of which they are capable when growing under favourable conditions.

Finally, annual plants occur in greater or less profusion. These include a few species of grasses; many species of Compositae, and also members of other families, such as Euphorbiaceae, Leguminoseae, Labiatae and Verbenaceae.

(2) THE EARTHY BANKS BORDERING CANE-FIELD PATHS.

The region of a typical cane-field path implied under this heading is actually part of the cane-field itself. It is the very edge of the field, and it marks the

limit of cultivation. It runs along the heads and the sides of the cane-rows, and gradually merges at the base of its slope into the central regions of the cane paths.

The soil factors as regards depth, moisture, tilth, &c. are practically the same for the banks bordering a cane-field as for the cane-field itself. Also, the restrictions placed in the growth of weeds by the activities of weeders during the first period in cane cultivation, are the same for both regions: for the weeders clear the banks of weeds at the same time as they clear the fields.

The chief point of difference between the two habitats is that in the very interior of a field of mature canes the light is of such low intensity and the cane plants are so closely grown, that few weeds (except certain creepers which use the cane stems as a means of support) are able to thrive. On the banks, however, the light conditions are favourable to the growth of plants of all kinds.

The above considerations lead one to expect firstly, that the plant population of the banks bordering cane-fields would consist chiefly of annual plants, for perennials would have insufficient time to establish themselves properly. Secondly, one would expect to find a great *variety* of species growing on the cane-field banks, since seeds of many kinds of plants growing in the cane-field paths, along the sides of high roads, in gullies and in waste places in the vicinity of the cane-fields, could easily be carried to the soil bordering the fields, and would there find favourable conditions for germination. Those plants possessing the most efficient means of dispersal would perhaps be expected to be represented in the greatest numbers, since such plants would arrive first on the newly exposed ground. Finally, any plant which when once established, is able to multiply rapidly, either by producing large numbers of seeds in a very short time, or by possessing ready means of vegetative reproduction, would be expected to become a conspicuous species in the cane-field bank flora.

The above predictions are borne out by actual observation. Firstly, annuals predominate on the banks of cane-fields. They include most of those already named in previous sections. Secondly, the first annual plants to colonise the banks are those possessing dispersal-mechanisms which will allow of wide-spread and rapid dissemination. They include those species which form the weed-flora of cane-lands in the early stages of cane growth, whose names have already been given. Especial mention might here be made again of members of the Compositae which enter into the first period weed-flora. These possess wind-borne fruits provided with hairy parachutes. Well-grown specimens of *Emilia sonchifolia* (Red Groundsel); *Sonchus oleraceus* (Sow Thistle, a yellow-flowered weed, which was in all probability inadvertently introduced by man into Barbados from Europe): *Erigeron canadensis* and *Erigeron spathulatus* (Flea Banes) frequently occur on cane-field banks, and by reason of their wind-borne hairy fruits, are amongst their first colonisers. Besides these, *Parthenium hysterophorus* (White Head); *Eclipta alba*: *Lagascea mollis* (Velvet Bush) and *Agaratum conyzoides*—Compositae with small but hairless wind-borne fruits, are also common. Other conspicuous annual weeds, which mature later on cane-field banks, include various members of the family Leguminoseae, (*Teramnus uncinatus* (Rabbit Vine); *Phaseolus semierectus* (Wild Dolly); *Vigna luteola* (Yellow Vigna or Rouncival); *Mucuna pruriens* (Cow-Itch) &c.,—weeds which

are able to thrive also in the very interior of cane-fields, where they climb up the cane stems.

Amongst the perennials which reach their flowering stage just before the canes are reaped from the fields whose pathway banks they inhabit, *Stachytarpheta indica* (Vervain); *Crotalaria retusa* and *verrucosa* (Sweet Peas) and *Cassia polyadena* (Wild Tamarind) may specially be noted.

Finally, the following quick-growing annuals frequently occur at the edges of cane-fields, especially in the south-eastern part of Barbados.

1. *Physalis pubescens* (Solanaceae) Pops.
   An erect, annual, herbaceous plant (height about 1 foot), of luxuriant growth. The leaves are simple, ovate, of length about 2 inches, and breadth 1 inch. The branches are repeatedly forked, and in each angle a flower (or fruit) is borne. The flower is small, lemon-yellow, with purple throat and purple anthers. The fruit is a berry of diameter ½ inch, enclosed in the angular bladder-like calyx, of length ¾ inch. It may be dispersed by birds but it frequently dries up and liberates its tiny seeds, which may be carried by wind.

2. *Physalis linkiana* (Solanaceae) Pops.
   Very similar to the above, but distinguished from it by its rounder fruit-bladders, and its slightly hairy stems and leaves.

3. *Physalis minima* (Solanaceae) Pops.
   Possesses smaller leaves and flowers than *P. pubescens* and is hairy. The anthers are yellow not purple.

4. *Phyllanthus niruri* (Euphorbiaceae).
   An erect annual herb of height up to 1½ feet. The leaves are small, thin, arranged in pairs on opposite sides of the stems, pale-green and roundish in shape. Each leaf bears a small flower in its axil. The fruit is a tiny capsule containing a few minute seeds.

(3) ROADS OF THE SCOTLAND DISTRICT.

The roads of the Scotland District of Barbados, being less used than those of the coralline parts of the Island, and being built on a softer substratum of crumbly sandstone and clay, do not exhibit the same features as the high roads of the coral regions. The Scotland District roads, for instance, do not possess steep rocky banks so characteristic of the much-used limestone roads of the coralline regions of Barbados, nor do they ever lie in deep cuttings hewn through solid rock. They are, however, bordered in most cases by cane-fields, and, on the whole they may be compared with those almost unkept paths which divide the cane-lands in the coralline part of the Island. They may, therefore, be conveniently included under the same heading as those cane-field paths.

The more important Scotland District roads are bare and hard except near their margins, where they gradually merge into the cane-lands either sloping gently to the level of the fields, or sinking slightly into shallow gutters lying immediately along the edges of the fields.

The flora of the waysides of these roads is very much like that of the earthy banks of the paths through the cane-fields of the coralline regions already described. The conditions of growth, and the factors governing the colonisation of the soil of these Scotland waysides, are almost identical with those in operation in the cane-field wayside banks of the other districts. One finds growing on them a great variety of annual weeds; along with certain perennial plants such as *Stachytarpheta indica* (Vervain); *Cassia polyadena* (Wild Tamarind); and the two species of *Crotalaria* (Sweet Peas), which grow sufficiently quickly as to produce flowers in a comparatively short space of time.

(D) WAYSIDES OF THE STREETS OF BRIDGETOWN AND OF THE LARGER VILLAGES OF BARBADOS.

Most of the streets of Bridgetown are bordered by more or less shallow gutters, which carry off rain water during wet weather into drains which lead to the sea. In many cases the gutters are constructed of tiles or slabs of stone, and occasionally of concrete. Usually they are simply hollows in the ground along the street sides. They present the same conditions of growth as do the gutters at the bases of the rocky roadside banks of the highways of the coralline parts of Barbados. The factors governing the growth of plants in them need not again be considered.

The commonest plant found in street gutters is *Cynodon dactylon* (Devil's Grass). This plant is the most difficult of all to eradicate, since the hoe of the weeder can seldom uproot its underground stems. It appears in newly cleaned gutters even in the driest weather within a fortnight after the weeders have passed on. Another common gutter weed is *Parthenium hysterophorous* (Whitehead). This plant produces such large numbers of tiny fruits in so short a time, that its seeds can never be removed even from the scanty soil of gutters. *Vernonia cinera* (Compositae) is also common in street gutters. It is easily spread by means of its hairy fruits.

Besides the above, perennial grasses such as *Sporobolus indicus* (Wire Grass),; *Paspalum conjugatum; Panicum prostratum; Eleusine indica* and *aegyptica;*—annual grasses such as *Chloris radiata; Eragrostis purshii* and *pilosa;* and *Lepiochloa mucronata* occur commonly in gutters, but their abundance varies greatly with moisture conditions.

Annual herbs are frequently found in different stages of growth in street gutters. The rapidly growing *Amaranthus viridis* (Pigweed) and the tooth-leaved Nettle (*Fleurya aestuans*) are especially common where a fair amount of soil has collected, and *Euphorbia hypericifolia,* along with other species of *Euphorbia,* are almost always found. Many other annual plants make their appearance in wet weather in the more neglected gutters, their abundance also being decided by local conditions.

SECTION II.—PLANTS ARRANGED IN NO ECOLOGICAL GROUPING.

In this last section it is intended to describe the more common plants of Barbados which occur in no ecological groups, but which are found growing in habitats that have in most cases, been chosen or prepared for them. Most of

these plants are introduced plants, and it is interesting to note their places of origin, so that one may become impressed by the fact that the most conspicuous part of the present-day vegetation of Barbados consists of exotic species derived from many different countries.

The plants of this class may be considered under five heads:—

(1) *Shade trees.*

(2) *Trees with showy flowers, or otherwise ornamental.*

(3) *Fruit trees.*

(4) *Garden plants.*

(5) *Food plants* (other than fruit trees).

(1) THE SHADE TREES OF BARBADOS.

CHAPTER XVIII.

These trees are arranged below in their approximate order of commonness. The specimens are found growing near dwelling houses, along roadsides, in estate yards, and here and there in or near cane-fields. Most of them are introduced plants. In the lists, where no special mention is made of the origin of a tree, it is to be assumed that the tree has been introduced by man into Barbados. Indigenous trees are described as such.

1. *Swietenia mahagoni* (Meliaceae) Mahogany.
A tall deciduous tree with numerous pinnate leaves each with six to ten pairs of small pointed leaflets. The flowers are very small, and are borne in panicles. The fruit is a large, erect, pear-shaped capsule. It has a thick, woody pericarp, which breaks explosively in five segments when dry. The seeds are winged. The tree sheds its leaves in April and May. Before dropping, the leaves display autumnal tints of yellow, brown and red. When the tree is almost bare the fruits begin to dehisce, and the new leaves to sprout (in June and July). The flowers are produced at the same time. The mahogany is grown chiefly in gardens, groves and occasionally along roadsides. The tree was introduced into Barbados between 1780 and 1800. It is a native of Honduras.

2. *Tamarindus indica* (Leguminoseae-Caesalpinoideae). Tamarind.
A tall tree, very much branched, with numerous pendulous, pinnate leaves, each with ten to eighteen pairs of small oblong leaflets. The flowers are arranged in racemose clusters. They are small and odorous, and are protected in the bud by loosely-attached pink bracts. The fruit is an indehiscent legume, cylindrical in shape, and slightly curved; length—about four inches. It has a fragile brown pericarp and contains one to eight seeds embedded in sticky brown pulp. The Tamarind flowers in June and July and its fruits are ripe in March to May. The fruits are exported from the Island in considerable quantities. The tree is partly deciduous, shedding some of its leaves in the dry season. Most

gardens possess at least one Tamarind tree. The tree is a native of the East Indies, and was first planted in Barbados in 1650 or thereabouts. It is an established fact that the Tamarind was introduced by the Spaniards into Mexico, and it may thus have been imported from there into Barbados.

3. *Ficus nitida* (=*aurea?*) (Moraceae). Evergreen.
A comparatively low tree with wide-spreading, horizontal branches. These branches are thick, and are in most cases unsupported by props. The underground root system is very extensive. Hanging roots are not numerous. The leaves are small (usually about one and a half inches long), green, leathery, elliptical, smooth, and almost obtuse at the apices. The "figs" are borne in pairs in the leaf-axils. They are sessile and look like peas. Each has two or three small bracts at the base and a small mouth closed by scales. The Evergreen frequently grows near managers' houses on sugar estates, where it forms shade sufficient for saddle horses and often for many estate animals also. The tree was introduced into Barbados before 1750. It is a native of India.

4. *Tecoma leucoxylon* (Bignoniaceae). White Wood.
A more or less evergreen tree of medium height. The branches are not very wide-spreading. The leaves are compound, consisting of three (and sometimes more, up to eight) smooth, rigid, oval leaflets. The length of a leaflet is about three inches. The flowers are funnel-shaped, of length two and a half inches and pink in colour. The fruit is a long pod-like capsule—of length six to eight inches, which splits into two valves, and liberates the numerous two-winged seeds. The White Wood flowers most prolifically in the dry season, when also many of its leaves fall to the ground. The tree commonly forms groves, especially on land and along roadsides near the sea. It is a South American and West Indian tree, and is probably indigenous to Barbados.

5. *Hura crepitans* (Euphorbiaceae). Sand-box.
A large, symmetrical, much-branched tree, with stout trunk and strong limbs. It is deciduous, although it rarely sheds all its leaves at once. Generally the leaves drop gradually as the dry season proceeds, and at the end of an unusually severe period of drought, few of them remain on the tree. The bark of the Sand-box is thick, and is covered with short, sharp prickles. The leaves are more or less heart-shaped, and of length about four inches and breadth three inches. The leaves and twigs exude a milky juice when bruised. The flowers are unisexual; there are female flowers and male flowers borne separately on one and the same tree. They are produced most abundantly at the beginning of the wet season. The fruit is a many chambered capsule, which dehisces explosively when dry into segments, and thus liberates the flat seeds. The woody fruit-covering, with the seeds extracted, was in former times used as a sand sprinkler in lieu of blotting paper—hence the name "Sand-box". Filled with lead, the fruit forms a handy paper weight. The Sand-box tree is commonly grown in gardens and along the roadsides in all parts of Barbados. It is probably an indigenous plant.

6. *Oreodoxa oleracea* (Palmae). Cabbage Palm.
This well-known palm often reaches a height of 100 feet. Its trunk is straight and of diameter three to five feet. The outer covering is slightly ribbed but is otherwise smooth. The upper part of the trunk for a distance of about twenty feet is covered by the sheathing green leaf-bases of the outer leaves of the crown. The leaves are large and compound (pinnate). The bud in the centre of the crown is sometimes eaten as a vegetable.—hence the name "Cabbage Palm." The flowers are borne in a much-branched and profuse inflorescence which, when young, is enclosed in a large, leathery bract (spathe). This bract falls off when the fruits begin to ripen. The fruit is a small berry of diameter three-quarter inch. The Cabbage Palm is indigenous to Barbados. It is commonly seen along roadsides and avenues.

7. *Casuarina equisetifolia* (Casuarinaceae). Casuarina, Mile Tree.
A tall, quick-growing tree, with slender branches and rugged bark. The older branches are drooping. The younger are relatively short, and clothe the elongated main stem in such a way as to form a graceful, conical spire, frequently reaching upwards to a height of 150 feet. This spire waves to and fro in the wind. The ultimate twigs of the tree are green, of length eight to ten inches, and are each composed of thirty to thirty-five segments. The segments are finely ribbed, and where they join, a ring of tiny teeth-like leaves occurs. The flowers are unisexual, the male flowers being arranged in terminal spikes, and the female in stalked spherical heads. The fruit is woody, and not unlike a small fir-cone. The seeds are winged, and are protected until shed between the woody scales of the fruit. The root system is very extensive, so that few plants can live near a well-established Casuarina tree. The features of the tree indicate that it is a true xerophyte, being able to withstand drought very successfully. The Casuarina originated in North Australia, or the Indian Archipelago, and was probably introduced into Barbados about 1870. It is frequently grown together with the Cabbage Palm along roadsides, and forms a conspicuous feature in the landscape in many parts of the Island.

8. *Albizzia lebbek* (Leguminosae.—Mimosoideae). Woman's Tongue, Barbados Ebony.
A medium-sized, more or less deciduous tree, with the lower branches slightly drooping. Leaves—bipinnate, each consisting of two to four rows of leaflets, with three to nine leaflets in each row. The leaflets are one inch to two inches long when mature. The flowers are grouped in heads. They have numerous long stamens of a white or greenish colour, and are sweet-scented. The fruit is a flat, papery pod containing few seeds. These it eventually sheds by dehiscing into halves. For a long time, however, the seeds are loose within the pods and are rattled about by the wind. The tree produces new leaves and flowers in April and May,—i.e. at the end of the dry season. The fruits become noticeable, but are still green in August. They turn brown in November, and remain in that state until the following April to July, during which time the leaves have almost all dropped off, so that during the months of March to May the most conspicuous feature of the tree is the very large num-

bers of pale-brown membranous pods,—leaves being almost entirely absent. Sometimes the tree flowers precociously in September. The Woman's Tongue is a native of Bengal, and was probably introduced into Barbados in the 19th century. It is grown in gardens chiefly.

9. *Terminalia catappa* (Combretaceae). Barbados Almond.
A fair-sized tree with more or less regularly-arranged branches, which bear tufts of large leaves of a roundish spoon shape. The leaves are shed often twice or more times during the year. Before falling the leaves turn bright red. The flowers are borne at the ends of the twigs in short racemes; they are small and white. The fruit is an almond-shaped drupe with green pericarp, an extremely hard stone enclosing the seed. The Barbados Almond originated in Africa or Asia. It is a regular member of the sea-shore bushland in many regions in the East, and it is interesting to note that, although probably introduced into Barbados by man, it has established itself in the sandy bushland (Coccoloba) plant association of the Island.

10. *Cordia collococca* (Boraginaceae). Clammy Cherry.
A tree of height up to thirty feet. The branches are more or less horizontal and twisted. The leaves are broad and of length four inches; they are white on their under surfaces. The inflorescence is a many-flowered loose panicle. The flowers are small and white. The fruit is a semi-transparent, pale orange-coloured berry, of diameter ¾ inch. It contains a very sticky pulp, which aids in the dissemination of the seeds by the fact that birds which try to eat it, carry away many of the seeds attached by the mucilage to their beaks. The Clammy Cherry flowers in April and May, and its fruits are ripe in July. It does not shed all its leaves in the dry season, and is therefore not markedly deciduous. The plant is a native of the West Indies, and may be indigenous to Barbados. It is fairly commonly grown in gardens.

11. *Eriodendron anfractuosum* (Bombacaceae). Silk Cotton.
A deciduous tree of well-marked vegetative habit, and of characteristic appearance. In Barbados it seldom grows higher than sixty feet, although in other West Indian Islands (such as Trinidad and Jamaica) it grows as tall as 150 feet. The trunk of the Barbados specimens is four to six feet in diameter, and is furnished with flat plank-like buttress roots, which often reach far up the trunk. It appears that the drier the soil in which the tree grows, the more developed are the buttresses. The branches of the tree come out horizontally from the trunk in a very stiff and formal manner, the lowermost being long, and at a height from the ground of about half the height of the tree. The higher branches are short, so that the crown of the tree is of a squat conical shape. The thick bark is covered with short prickles. The leaves are deeply divided, consisting of five to seven leaflets each of length about four inches, attached radially to the end of the leaf stalk. The Silk Cotton tree sheds all its leaves at the beginning of the dry season (February). It remains bare until about March, when the large brownish flowers are produced in profusion. The fruits quickly set, and become conspicuous objects.

They are large pods,—lemon-shaped and green. Later (in May) the pods turn brown and burst, liberating the seeds. These are enclosed each in a mass of silky wool which permits of the wind carrying away the seeds and so disseminating them. When the pods have burst, the new leaves are put out. These grow out from the buds, which, during the dry season, have been protected by bud-scales. The young leaves are pale-green. They give the tree a very striking appearance at this time, reminding one of the trees of temperate countries in Spring. It is interesting to note that when it happens that a Silk Cotton tree bears few or no fruits, its period of leaf production is much earlier than that of an individual which bears abundant fruits. Also on one tree, those branches which possess few or no fruits produce leaves earlier than those branches which are laden with them. The reason seems to be connected with the question of the relative amount of sap or of stored food material in different individuals, or in different parts of the same individual. The Silk Cotton tree is an indigenous tree. At one time it was undoubtedly very common in the Island, but nowadays it is found only occasionally along roadsides or in gullies.

12. *Haematoxylon campechianum* (Leguminoseae-Caesalpinoideae) Logwood. A small deciduous tree, with bent trunk and spiny crooked branches. The leaves are pinnate, with 3 to 4 pairs of leaflets in each. The leaves are shed usually in January and the next crop spring out in May. The young leaves are red in colour. In March the flowers are produced. These are small, and grow in great profusion in short racemes all along the branches of the tree. They are yellow in colour and sweet-scented. The fruit is a small, pointed, membranous legume, of length 1½ inches, and contains 1 to 3 seeds. The Logwood is a native of South America, and is now cultivated in many tropical countries where, as in Jamaica, it is grown for the brown or black dye obtained from the wood. It is probably not indigenous to Barbados, and has never been grown in any quantity in the Island.

13. *Crescentia cujete* (Bignoniaceae). Calabash.
A much-branched, small deciduous tree with a flat crown. The leaves are borne in clusters on protuberances of the branches. They are leathery and spatulate in shape, and of length 4 to 8 inches. The old leaves are shed in December, and the fresh leaves grow out in March. The flowers are large and cream-coloured. They are borne singly on the trunk of the tree (cauliflory). The fruit is a large berry with a woody outer layer and pulpy contents, in which numerous flat seeds are embedded. The shape of the fruit varies. It is usually spherical, and of diameter 4 to 12 inches. The shell is used as a utensil. The tree flowers chiefly during the dry season, and the fruits remain attached to the stem for several months. The seeds are probably disseminated by birds or other animals, which pick them up after the fruit has decomposed. The Calabash is a native of South America and the West Indies, and may be indigenous to Barbados. It is stated by Ligon to have been fairly common there in 1650. It is to be seen growing chiefly near the labourers' huts in all parts of the Island.

14. *Pithecolobium unguis-cati* (Leguminoseae-Mimosoideae) Bread-and-Cheese. This plant is sometimes allowed to grow into a tree, but usually it is cut back so as to form a hedge. The leaves consist each of two oval leaflets of length about one inch. The inflorescence is spherical, and consists of numerous small flowers, with long slender stamens. The fruit is a red, curled, dehiscent legume, which contains several black seeds, each partly enclosed in a fleshy edible aril. This aril probably attracts birds, which devour both aril and seed, and thus bring about the dissemination. The tree produces several crops of flowers during the year;—the number of these crops depending on the distribution of the rainfall. The Bread-and-Cheese tree may be indigenous to Barbados. It is a South American and West Indian plant. It is seen growing in Barbados near labourers' huts and in hedges.

N.B.—Pithecolobium saman.—The Saman Tree of South America, &c., is occasionally grown in Barbados, having recently been introduced into the Island. It is never seen there in its natural massive size, and is grown chiefly in gardens .

15. *Ficus suffocans* (=*?laurifolia*) (Moraceae) Bearded Fig.
(It is supposed by some that the name Barbados was derived from the appearance of this Fig Tree or of some similar species characterised by numerous, fibrous, dangling roots, growing from the branches). The Bearded Fig sometimes grows into a large erect tree with numerous branches bearing dense mats of aerial roots. Many of these reach to the ground and change into woody props, or grow alongside the main stem and become fused into it, giving rise in this way to a deeply ribbed trunk. It is in this form that the Bearded Fig tree is seen in gardens and in regions where the land is flat, but the tree is more often seen in Barbados in what is perhaps its more natural habitat, *i.e.*, in rocky places such as gully walls and inland cliffs (see "Gully-wall and epiphytic shrubs," and "Plants of the undercliff regions"). Here it grows attached to the rock face or perched near the summit of rocky eminences, in which position its epiphytic features are very well shown. The leaves of the Bearded Fig are leathery, elliptical in shape and of length 4 to 6 inches; and breadth 1½ to 3 inches. The fruits are small yellow "figs," not unlike those of the Evergreen tree but larger. The tree is a native of the West Indies, and is probably indigenous to Barbados.

16. *Caryota urens* (Palmaceae).
A palm with columnar stem growing up to a height of 40 to 60 feet. The leaves are twice pinnate, and the inflorescence hangs down like a brush. The fruit is a berry. *Caryota* is a native of the East Indies. It is frequently grown in gardens in Barbados.

17. *Acrocomia sclerocarpa* (Palmae) Macaw Palm.
Indigenous. (See under "Plants of the forest"). The Macaw Palm is occasionally grown in gardens in Barbados.

(2) TREES WITH SHOWY FLOWERS, OR OTHERWISE ORNAMENTAL.

CHAPTER XIX.

The trees tabulated below are arranged in the relative order of commonness. Most of them are plants introduced by man. They are found growing in gardens chiefly. In Queen's Park, Bridgetown, there is perhaps the most varied selection of flowering trees to be found in Barbados.

1. *Poinciana regia* (Leguminoseae,—Caesalpinoideae) Flamboyante.
A deciduous tree, growing up to 50 feet in height. The trunk is usually bent, and the branches tortuous. The main branches are more or less horizontal, so that the tree has a shallow flattish crown. The ends of the branches bend downwards, giving the tree a "weeping" habit. The leaves are put out in late June or July. They are large and bipinnate with very numerous small leaflets. The majority of the leaves are shed during the first few weeks of the dry season, (in February and April), and soon afterwards the flower buds make their appearance. The flowers expand in late May or June, when the tree takes on an aspect of extreme gorgeousness. The inflorescences are racemose, and are borne at the ends of almost every twig of the tree. Each consists of 10 to 20 large flowers of usually a bright-scarlet colour. A certain variety of Flamboyante has orange-red flowers, and another, brick-red flowers. The flowering period extends into September. The fruits quickly make their appearance. They are flattish pods, and grow to a length often of 20 inches, and of width 3 inches. They eventually turn black. The pods remain on the tree for a year or more, and form a conspicuous feature of the tree,—especially during the months when it is devoid of flowers and leaves. Eventually the fruits dehisce into halves, and liberate the numerous hard-coated seeds. The Flamboyante originated in Madagascar, and was introduced into Barbados probably towards the end of the 19th century. It is grown in gardens.

2. *Plumeria alba* (Apocynaceae) White Frangipani, Jasmine Tree.
A small deciduous tree, with very tortuous, succulent, naked, grey branches. The leaves are borne in bunches at the ends of the forked twigs. They appear towards the end of the dry season (in early April). Their shape is oval and their length, when fully grown, about 12 inches. At the commencement of the dry season the foliage of the last year drops off. Quickly, when it has all fallen, the flowers make their appearance, and when these are fully opened the new leaves grow out from the bases of the axes which bear the flowers. The flowers are collected in umbel-like, stalked, terminal branches. The flower is white with a yellow centre, and is heavily scented. The tree bears flowers until September. Occasionally fruits are produced. These are large, broad, woody follicles, of which two are derived from each flower. The Frangipani grows easily in the driest soil. Cut branches lying on the ground are commonly seen to produce flowers and leaves without the branch having taken root. The tree is very lactiferous, and probably contains abundant stored food material in its stem and branches. The

Frangipani is a native of Mexico, and was brought to Barbados probably early in the 18th century.

Plumeria rubra (Apocynaceae) Red Frangipani.
This species bears red flowers, but is otherwise very like the above, except that it flowers perhaps rather earlier. Both species are found in most gardens in Barbados.

3. *Cordia sebestena* (Boraginaceae) Scarlet Cordia.
A medium-sized evergreen tree which bears broad fairly large leaves. The leaves are stiff and rough, and exhibit xerophytic features. The flowers are borne in conspicuous branches, the tree seldom being devoid of them. The fruit is a white drupe of which the fleshy layer has been derived from the calyx of the flower, a fact of some botanical interest. The Cordia is perhaps an indigenous plant. It is commonly grown in gardens in Barbados, but it is also found growing and reproducing itself freely in the sandy-bushland (Coccoloba) plant association of the sea shore.

4. *Citharexylum quadrangulare* (Verbenaceae) Fiddle Wood.
A medium-sized deciduous tree. Its leaves are numerous, and of a rich green colour when young. Before falling off at the beginning of the dry season, they turn salmon-pink or yellow. The new leaves are produced very soon after all the old leaves have fallen, provided that the soil is fairly moist. The oncoming of the wet season (May or June) causes the tree quickly to put out its new foliage. The flowers of the Fiddle Wood are small, white, and sweet-smelling. They are borne in pendulous racemes from the ends of the twigs. The tree produces three or more crops of flowers each year during the wet season, the first crop being put out almost as soon as the first leaves make their apparance.
The common name Fiddle Wood is probably a corruption of the French name of the tree—Bois fidele. The plant is probably indigenous to Barbados. It is a member of the forest association.

5. *Moringa oleifera* (=*pterygosperma*) Moringaceae) Horse-radish Tree.
A small slender tree, with leaves three times divided. The white flowers are borne in terminal racemes. The fruit is a long three-sided capsule, of length usually 1 foot and width 1 inch. It contains numerous closely-packed seeds, each of which possesses three membranous wings. A native of tropical Asia and India. The East Indians eat the cooked leaves and young fruits. The root is said to be a good substitute for horse radish. *Moringa* was introduced into Barbados early in the 19th century.

6. *Morinda citrifolia* (Rubiaceae) Wild Pine.
A small evergreen tree, with very large, shiny, oval, bright green leaves. The lower branches of the tree have a drooping habit. The flowers are collected on globose fleshy receptacles. They are small, white, waxy and sweet-scented. The ripe fruit is a large, yellowish, multiple fruit, consisting of the fused ovaries of the flowers and containing many black seeds. The fruit resembles somewhat a small pine-apple. It falls to the ground, and decays there into a putrid mass. The tree flowers almost

all the year round. The Wild Pine is an East Indian plant, and has perhaps not long been grown in Barbados.

7. *Guaiacum officinale* (Zygophyllaceae) Lignum Vitae.
A medium-sized evergreen tree, with wide spreading stout branches. The bark is thick, and is covered with a greenish crust, which peels off in flakes. The leaves are pinnate, and consist of two or three oval leaflets, each of length ½ to 1 inch. The flowers are very numerous, and are collected in terminal groups of 2 to 10 flowers. Each flower is flat, bright-blue in colour and 1 inch across. The fruit is a compressed yellow berry of length ¾ inch. It is shaped like an inverted heart. It contains two or three chambers, each with an oval seed surrounded by a thin red pulpy layer. Often all the seeds except one are aborted. The wood of the Lignum Vitae is very dense and hard, and exudes a gum which has medicinal uses. The tree grows very slowly, and flowers habitually twice a year. It is a North and Tropical American tree, and may be indigenous to Barbados. Ligon mentions it in his account of the flora of Barbados. It is found growing chiefly near residences in the country districts of the Island.

8. *Capparis cynophallophora* (Capparidaceae) Black Willow.
A small evergreen tree. Leaves; numerous, elliptical, with shining, dark-green upper surfaces, and scaly brownish-grey under surfaces. Length of leaf 3 to 4 inches. The flowers are grouped in short terminal cymes. They are white, and of diameter ¾ inch. They possess numerous long stamens. The ovary is stalked. The fruit is a pendulous, cylindrical, fleshy siliqua, of length up to 10 inches, and breadth ½ inch. It ruptures irregularly along one side, and flattens out, exposing a bright-red inner surface, to which are attached by slender threads, two rows of round soft-skinned seeds. In the seedling the leaves are linear and of length 5 to 8 inches and breadth ½ inch. The Black Willow flowers almost all the year round especially in May to September. If properly trimmed it grows into a dense symmetrical tree of imposing appearance.

9. *Capparis indica* (Capparidaceae) White Willow.
Very similar to the last, but the leaves are not so dark coloured above nor so grey below. The Willows are natives of South and Central America.

10. *Lonchocarpus violaceus* (Leguminoseae,—Papilionatae). Spanish Ash.
Indigenous. (See under "Plants of the forest"). The tree is commonly grown in gardens.

11. *Cassia fistula.* (Leguminoseae.—Caesalpinoideae) Purging Cassia.
A small tree with imparipinnate leaves, each with 5 to 9 pairs of large, pointed leaflets. The leaves are put out in June. During June and July the tree is covered with long pendulous racemes of fairly large bright-yellow flowers. The fruit is a long, cylindrical, indehiscent, black legume, of length often 20 inches, and breadth ¾ inch. It is divided into many chambers, in each of which is embedded a seed in

dark sticky pulp. The fruits remain on the tree for the greater part of the year. *Cassia fistula* is a common tree in the forests of India and Ceylon. It was perhaps introduced into Barbados in the early days of its settlement although there is some evidence that its seeds may have reached the West Indies through the agency of the South Equatorial Current. It is grown in gardens.

12. *Cassia grandis* (Leguminoseae,—Caesalpinoideae) Pink Cassia or Horse Cassia.

A small tree which possesses compound leaves each with 10 to 20 pairs of leaflets. The flowers are arranged in long racemes, and are of a pink colour. Legumes;—short (4 inches) and thick (2 inches diameter). The flowering and leafing periods are earlier than in *C. fistula. C. grandis* is a native of South America, and is also indigenous in the larger West Indies Islands.

13. *Cassia marginata* (=*javanica*) (Leguminoseae—Caesalpinoideae) Pink Cassia.

A small graceful spreading tree with a weeping habit. Compound leaves with 10 to 20 pairs of blunt oval leaflets. The flowers are rose pink, and are arranged in numerous racemes. The legumes are pendulous. The tree flowers in May. Place of origin East Indies.

A few other species of *Cassia* are occasionally grown in gardens in Barbados, but the above are the most common.

14. *Bauhinia kappleri* (Leguminoseae,—Caesalpinoideae) Napoleon's Cocked Hat.

A small slender deciduous tree, with large alternate, thin, bilobed leaves, 4 inches long. Flowers;—large, pink, arranged in few-flowered cymes. The legumes are dehiscent, and about 6 inches long. The tree sheds its leaves in February and puts out its flowers in May and June. It is a native of the East Indies.

15. *Bauhinia tomentosa* (Leguminoseae,—Caesalpinoideae) Bauhinia.

A shrubby tree very similar to the above, but the flowers are pale-yellow in colour, turning rosy when old.

16. *Melia azedarach* (Meliaceae). Barbados Lilac, Bead Tree.

A small deciduous tree, with slender drooping branches. Leaves;—imparipinnate, with 3 to 11 oval dentate leaflets of length 2 inches. Flowers arranged in large erect, terminal, cymose panicles. Each flower has 5 pale-violet petals of length ⅓ inch, and numerous dark-red stamens united to form a tube. The fruit is an almost spherical drupe, ¾ inch diameter, and of a yellow colour. The infructescences are pendulous. The lilac is a native of Persia and Syria.

17. *Nerium oleander* (Apocynaceae) Oleander.

A shrubby tree, not unlike the Frangipani in general appearance, except that its leaves are much narrower and the flowers smaller. The Oleander is a native of the Mediterranean region.

18. *Gliricidia maculata* (Leguminoseae,—Papilionatae) Madre.
A quick-growing deciduous tree, with long arching branches. In February the otherwise bare tree is covered with short racemes of pale-violet flowers, which are soon replaced by short green pods. The pods attain a length of 4 to 6 inches and then turn brown. By this time the tree is clothed with pinnate leaves, which remain on the tree from May to December. *Gliricidia* is much used in the Northern Antillean Islands as a wind break for cotton plants. It is a native of South America, and was but recently introduced into Barbados.

RARE LEGUMINOUS TREES WITH SHOWY FLOWERS.

1. *Agati grandiflora* (Papilionatae).
A small deciduous tree, with horizontal branches and slender stems. Leaves;—pinnate, of 14 to 20 pairs of leaflets. Flowers borne in small axillary groups. Each flower is very large (3 inches long), and of a cream or pink colour. The fruits are long thin legumes. *Agati* was introduced from the East Indies. It puts out its flowers in March to June.

2. *Andira inermis* (=*jamaicensis*). (Papilionatae). Wild Olive.
(Angelica of forests of South America, Jamaica, &c.) Bears numerous racemes of purplish flowers. The fruit is a small one-seeded drupe. *Andira* is a West African plant. Its seeds are often found cast up on beaches of West Indies Islands.

3. *Piscidia erythrina* (Papilionatae).
A small, much-branched, deciduous tree, with pale-green, compound leaves, each of 3 to 5 leaflets. The flowers are pale-red, and are grouped in large panicles. Legumes;—small, indehiscent. The tree is of West Indian origin.

4. *Erythrina corallodendron* (Papilionatae) Coral-bean Tree or "Shrove Tuesday."
("Bois immortel" of forests of South America, Trinidad, &c.). A medium sized tree, which bears very numerous red flowers in March and April.

5. *Peltophorum ferrugineum* (Caesalpinoideae).
A tall tree native of Ceylon and Malay. A good specimen is to be seen growing in Queen's Park. It bears numerous erect panicles of bright-yellow flowers, which are produced in March. The young shoots are covered with brown velvety hairs, giving them a rusty appearance.

NOTE ON THE PERIODICITY OF THE SHADE TREES, AND OF THE SHOWY FLOWERING TREES OF BARBADOS.

From records of observations of the main features of the vegetative activity of common trees belonging to the above groups as represented in Barbados, the following general conclusions may be drawn:—

1. DECIDUOUS TREES.

In the case of *deciduous* trees, (i.e. those trees which shed their leaves more or less completely once a year, such as Mahogany; Sand Box; Woman's Tongue; Silk Cotton; Flamboyante; Frangipani; Fiddle Wood; Cassias; and certain other Leguminous trees),—the period of leaf fall roughly coincides with the latter part of the dry season.

Leaf fall is known to botanists to be a definite physiological process resulting from a diminution in the supply of water to the leafy twigs. Whether the reduction in water supply is due to the drying of the soil, (as is the case with tropical deciduous trees), or to the inability of the root-system to absorb water because of a lowering of soil temperature, (as is the case with deciduous trees of temperate countries during winter), is of no account. It has been demonstrated that the reason why leaves drop when water shortage occurs is that a layer of tissue (cork) is formed, usually across the base of each leaf. Thus, even before the detachment of the leaf takes place, the wound is healed in advance. Although water shortage is the chief cause of leaf fall, other processes that go on in a plant, especially those connected with nutrition, are concerned in the bringing about of the formation of this separation layer or abciss layer.

Several factors are therefore responsible in deciding the date in the actual shedding of the leaves of a tropical deciduous tree. The chief are:—

(A) EXTERNAL.

(1) The *earliness or lateness* of the commencement of the dry season, and the occurrence or non-occurrence in it of breaks, when showers of rain replenish the supply of water in the soil.

(2) The *position, drainage, depth, composition, &c* of the soil in which the particular individual tree is growing, these factors being concerned with the actual amount of water available to the tree roots.

(B) INTERNAL.

(3) The *kind of tree* (whether Mahogany, or Silk Cotton or Flamboyante, &c.),—each species having its own peculiarities in connection with such process as (i) absorption at the roots, (which depends chiefly on the extent of the root system); (ii) rate of transpiration, (which partly depends on structure of the leaf;—whether its surface is protected so as to minimise evaporation, or whether the number of pores (stomata) in it is small or large, &c); (iii) production of flowers and fruits, which exercises a great drain on the sap content, so that a specimen of, say, a Silk Cotton tree which happens to produce few flowers or fruits, is frequently seen to drop its leaves later, and to produce its

new leaves earlier than one which produces a large crop of flowers and fruits; (iv) nutrition, (which depends on the properties of the leaf, and the rate at which chemical changes go on in the body of the tree).

(4) *The age of the tree,* (young trees often not shedding their foliage at all; others only in part).

By a consideration of the above factors, the differences between the periods of leaf fall, leaf production, &c., of trees of different species, or of individuals of the same species, may partly be elucidated. It must be borne in mind that the final result in any particular case is to be explained by the combined effect of the numerous and intricate factors that are at work.

2. EVERGREEN TREES.

In the case of *evergreen* trees, (i.e. those trees which shed few of their leaves in the dry season, so that the trees are never devoid of foliage, *e.g.* Evergreen; Tamarind; Casuarina; Palms; Cordia; Lignum Vitae; and the Willow), the same factors as laid out above are also effective.

In the preceding notes describing the features of each of these trees, it will be found that, for the most part, they have the following points in common:—

(i) Evergreen trees have very extensive root systems, so that they are able to draw on large volumes of soil for moisture.

(ii) The structure of their leaves is such that loss of water by transpiration is much reduced, i.e. the leaves have xerophytic characters. (e.g. the leaves of the Evergreen are small, leathery, covered with thick cuticle, contain a milky juice, &c., and those of the Casuarina are almost altogether absent:—the slender green stems of this tree taking on the role of leaves).

True evergreen trees have no definite time of leaf fall, although they drop most of their leaves in the dry months of the year, and put out most of their new leaves during the wet months.

The two groups Deciduous trees and Evergreen trees are not sharply defined, for several kinds of trees, (e.g. Sand Box and Whitewood) cannot strictly be placed in either class, since they frequently retain many of their leaves all through the dry season.

Special note may be made of trees such as Fiddle Wood and Barbados Almond, which habitually shed most of their leaves more than once in a year. It is hard to understand why this is so, probably the internal processes are here the chief factors that operate.

In conclusion it is interesting to note that the common deciduous Barbados shade trees and trees with showy flowers may also be arranged fairly definitely into two groups in accordance with the habit of some in producing their flowers at the same time as they produce their new leaves, and of others in producing flowers and leaves at different times.

Examples of trees which produce flowers and new leaves together are—Mahogany; Woman's Tongue; Bread-and Cheese; Frangipani; Fiddle Wood; and Barbados Almond.

Examples of trees which produce flowers and leaves at different times are—Silk Cotton; Flamboyante; and species of Cassia. The habit of a tree in connection with its flowering (and subsequent fruiting) period may have some influence on the time of its leaf-fall.

(*To be continued in next Edition*).